INEEL/EXT-01-00666
Revision 2

Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals

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ABSTRACT

The *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals* provides information about the project description, project organization, and quality assurance and quality control procedures that will be used to sample the residuals remaining in the tank systems following decontamination activities. This document is used to specify the procedures for obtaining the data of known quality required by the closure activities for the Idaho Nuclear Technology and Engineering Center Tank Farm Facility. The data from this sampling effort will be used to support Idaho Hazardous Waste Management Act/Resource Conservation Recovery Act closure and Department of Energy Tier 1 Closure.

FOREWORD

In 1989, the U.S. Environmental Protection Agency (EPA) published *Guidance for Conducting Remedial Investigations and Feasibility Studies under the Comprehensive Environmental Response, Compensation, and Liability Act* (EPA 1988). This document stated that a Sampling and Analysis Plan (SAP) consisted of two separate documents: a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP). In 1998, EPA published *EPA Guidance for Quality Assurance Project Plans EPA QA/G-5* (EPA 1998), and in 2001, EPA published *EPA Requirements for Quality Assurance Project Plans EPA QA/R-5* (EPA 2001). These recent documents expand on the guidance provided in the 1989 EPA Guidance. Most notably, the 1998 and 2001 documents take the elements defined in the *1989 EPA Guidance*, which previously required both an FSP and a QAPP to implement, and combine them into one document. Thus, EPA's 1998 and 2001 direction implies that only a single QAPP document is required for each sampling and analysis activity. To alleviate confusion between the old and new nomenclature, this SAP includes all the elements required in a QAPP and in an FSP, regardless of which EPA guidance is followed. To demonstrate this compliance, and to aid readers in locating specific information of interest, a cross-reference among the *EPA 1989 Guidance*, the *EPA 1998 Guidance*, the *EPA 2001 Requirements*, and this document is provided.

The *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals* addresses the collection of data of known quality as required by the EPA and the Idaho Department of Environmental Quality for Idaho Nuclear Technology and Engineering Center Tank Farm Facility closure activities at the Idaho National Engineering and Environmental Laboratory.

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TABLES

ACRONYMS

AA	alternative action
AL	action level
ALARA	as low as reasonably achievable
ARDC	Administrative Record and Document Control
CFR	Code of Federal Regulations
COC	chain of custody
CV	coefficient of variation
DEQ	Department of Environmental Quality
DOE	Department of Energy
DOE-ID	Department of Energy Idaho Operations Office
DQA	data quality assessment
DQO	data quality objective
DVB	diversion valve box
EA	Environmental Affairs
EE	end effector
EPA	Environmental Protection Agency
EQL	Estimated Quantitation Limit
ER	environmental restoration
ES&H	environmental, safety, and health
ESH&Q	environmental, safety, health, and quality
FSP	Field Sampling Plan
FTL	field team leader
GC	gas chromatography
HASP	health and safety plan
HDPE	high-density polyethylene

HLW	high-level waste
HSO	health and safety officer
HWMA	Idaho Hazardous Waste Management Act
ICP	inductively coupled plasma
IH	industrial hygienist
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
JSS	job-site supervisor
LDUA	Light-Duty Utility Arm
LLW	low-level waste
MCP	management control procedure
MDL	method detection limit
MLLW	mixed low-level waste
MS	mass spectrometry
NWCF	New Waste Calcining Facility
OSHA	Occupational Safety and Health Administration
PA	performance assessment
PCB	polychlorinated biphenyl
PE	Professional Engineer
PEW	process equipment waste
PM	project manager
PQAO	project quality assurance officer
PRD	program requirements directives
PSQ	principal study question
QA	quality assurance
QAP	Quality Assurance Plan

QAPP	Quality Assurance Project Plan
QC	quality control
RAL	Remote Analytical Laboratory
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
SAP	Sampling and Analysis Plan
SAR	Safety Analysis Report
SBW	sodium-bearing waste
SC	sample custodian
SMO	Sample Management Office
SOP	standard operating procedure
SOW	statement of work
SVOA	semivolatile organic analysis
SVOC	semivolatile organic compound
TC	toxicity characteristic
TCLP	toxicity characteristic leaching procedure
TFF	Tank Farm Facility
TRU	transuranic
U.S.	United States
UCL	upper confidence limit
VOA	volatile organic analysis
VOC	volatile organic compound
WCF	Waste Calcining Facility
WGS	Waste Generator Services
WTS	waste technical specialist

Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals

1. PROJECT DESCRIPTION

1.1 Purpose

This sampling and analysis plan (SAP) describes the sampling, analysis, and quality assurance and control (QA/QC) procedures to be used for the characterization of the post-decontamination residuals remaining in the tank heel, vault sumps, diversion valve boxes (DVBs), and cooling coils for Tanks WM-182 and WM-183 at the Idaho Nuclear Technology and Engineering Center (INTEC) Tank Farm Facility (TFF) at the Idaho National Environmental and Engineering Laboratory (INEEL).

This SAP is a combined Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP) in accordance with United States (U.S.) Environmental Protection Agency (EPA) guidance (EPA 1998, 2001). The elements of a QAPP present the activities, organization, and QA/QC protocols to achieve the data quality objectives (DQOs) of the sampling and analysis effort. The elements of an FSP specify sampling and analyses required to ensure compliance with the regulatory requirements for closure as defined by the Idaho Hazardous Waste Management Act (HWMA) (State of Idaho 1983) and the Resource Conservation and Recovery Act (RCRA) of 1976 (42 USC 6901, 1976), and with U.S. Department of Energy (DOE) closure requirements. This SAP is based on the requirements stated in the EPA *Guidance for Quality Assurance Project Plans*[a] (EPA 1998). This SAP also will ensure compliance with the QA/QC requirements of DOE's management and operations contractor, Bechtel BWXT Idaho, LLC; EPA Region 10; the DOE Idaho Operations Office (DOE-ID); DOE Headquarters; and the Idaho Department of Environmental Quality (Idaho DEQ). This plan will serve as the governing document for all activities conducted in support of the post-decontamination characterization of the residuals present in WM-182 and WM-183 tank system components.

1.2 Background

The TFF includes eleven belowground 300,000-gal and 318,000-gal tanks (hereafter referred to in this document as 300,000-gal tanks) and four 30,000-gal tanks. Each tank, numbered WM-180 through WM-190, is enclosed within a concrete vault. The TFF was designed primarily to receive liquid wastes from nuclear fuel reprocessing operations at the Idaho Chemical Processing Plant, now called INTEC. Reprocessing operations to recover ^{235}U began in 1953 and ceased in 1992. The liquid wastes were stored in the tanks for eventual solidification into a granular calcine at the Waste Calcining Facility (WCF) and, later at, the New Waste Calcining Facility (NWCF). The TFF currently receives liquids from the process equipment waste (PEW) evaporator; the liquids are derived from waste produced by plant operations such as fuel storage, sample analysis, off-gas cleanup, and equipment and facility decontamination.

Because the tanks at the TFF do not meet HWMA/RCRA secondary containment requirements or current structural seismic standards, the TFF is to be closed in phases beginning in 2003. The first phase

a. To demonstrate compliance to EPA requirements and guidance documents, as stated in the Foreword, and to aid readers in locating specific information of interest, a cross-reference between the *EPA 1989 Guidance* document, the *EPA 1998 Guidance* document, the *EPA 2001 Requirements*, and this document is provided as Appendix A.

of the closure will include Tanks WM-182 and WM-183 and will serve as a proof-of-process demonstration of waste removal, decontamination, and sampling techniques.

1.3 History of Tank WM-182 and WM-183

Tanks WM-182 and WM-183 were built between 1954 and 1955 and were used primarily to store first-cycle raffinate wastes resulting from the processing of aluminum and zirconium nuclear fuels. Since beginning service in 1956, approximately 1,604,100 gal of Tank WM-182 waste was calcined during five calcination campaigns.

Tank WM-183 has been filled and emptied to heel level three times and has contained aluminum and stainless-steel fuel reprocessing raffinates. Sodium-bearing waste (SBW), mixed low-level waste (MLLW), and low-level waste (LLW) have been introduced to the TFF (including Tanks WM-182 and WM-183). MLLW and LLW were sent to the PEW evaporators, and the bottoms from the evaporators were subsequently discharged to the TFF.

Tank WM-183 has contained a greater variety of waste, and the tank heel will likely have more precipitated solids than Tank WM-182. Tanks WM-182 and WM-183 now contain 10,800 gal and 12,100 gal of SBW, respectively (DOE-ID 2001a).

1.4 Purpose of Sampling

The overall purpose of the post-decontamination sampling and analysis for the WM-182 and WM-183 tank system residuals is to:

- Determine that hazardous wastes are not left in place in the TFF tank system. Wastes presently in the tanks are hazardous waste (as determined by the toxicity and corrosivity characteristic). Therefore, the mean characteristic of the post-decontamination residues remaining in each individual tank must be shown to be less than the toxicity characteristic (40 Code of Federal Regulations [CFR] 261.24, Table 1, 2001) and have a pH between 2 and 12.5.

- Determine whether or not the post-decontamination mean concentrations of radioactive and hazardous constituents remaining in the TFF meet the HWMA/RCRA clean-closure action levels specified in the *Idaho Hazardous Waste Management Act/Resource Conservation and Recovery Act Closure Plan for Idaho Nuclear Technology and Engineering Center Tanks WM-182 and WM-183* (DOE-ID 2001a), hereafter referred to as the HWMA/RCRA Closure Plan.

- Determine whether or not the residuals remaining in the TFF tank systems have activities that meet DOE Order 435.1 (DOE 2001a) radioactive waste management performance assessment (PA)[b] requirements for closure of the facility.

Samples from the post-decontamination residuals in the WM-182 and WM-183 tank heels and residuals of the final rinse solutions present in the tank vault sumps and DVBs must be collected, analyzed for a group of parameters, and pass specific criteria to satisfy HWMA/RCRA and DOE requirements for TFF site closure. Rinsates collected from associated waste transfer lines will be addressed in the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the Process Waste Lines from INTEC Tank Farm Facility Tanks WM-182 and WM-183* (INEEL 2001a).

b. DOE-ID, 2001, *Performance Assessment for the Tank Farm Facility Idaho Nuclear Technology and Engineering Center*, DOE-ID/EXT-01-10966, Idaho Falls, Idaho (in print, expected December 2001).

Additional samples of post-decontamination residuals will be taken from the tank cooling coils and tested for chromium.

It is known that the cooling coils contained chromium as a corrosion inhibitor. It is also known that the contents of the cooling coils never came in contact with the tank waste. Therefore, only chromium is of interest in the cooling coil rinsates, a specific action level for the chromium in these rinsates is established, and only chromium data from the analyses of the cooling coil rinsates will be used in assessing whether or not TFF residuals meet the HWMA/RCRA clean-closure action levels.

Sampling efforts undertaken during process operations have yielded some process-specific data. Additional sampling efforts that were conducted in 1999 and 2000 yielded data about tank wastes before the start of decontamination activities. These initial waste characterization data are analyzed and summarized in Section 3.2 of this SAP.

1.5 Analytical Laboratory

The laboratory chosen for conducting the analyses will have the appropriate level of qualified personnel, the appropriate instrumentation, an approved quality assurance plan (QAP), approved analytical methods, and appropriate internal standard operating procedures (SOPs) to perform the required analyses. The selected laboratory will be approved for use as documented by their inclusion on the INEEL-approved suppliers list. The QAPs and SOPs for the laboratory (or laboratories) selected for performing the required analyses will be available for review by project personnel.

2. PROJECT ORGANIZATION AND RESPONSIBILITIES

The WM-182 and WM-183 tank system closure has a clearly defined project organization. This will ensure that project closure objectives, data gathering and reporting, data evaluation and interpretation, closure design, and operational safety meet INEEL requirements. Table 1 lists project personnel and their responsibilities. The table is not intended to imply that a separate individual is required for each project role listed. One individual may perform more than one project role. The following subsections outline the specific duties of the project personnel associated with each role throughout the post-decontamination characterization effort.

2.1 Project Manager

The project manager (PM) will ensure that all activities conducted during the project comply with INEEL management control procedures (MCPs) and program requirements directives (PRDs), and all applicable requirements of the U.S. Occupational Safety and Health Administration (OSHA), EPA, DOE, U.S. Department of Transportation, and State of Idaho. The PM coordinates all document preparation and all field and laboratory activities, data evaluation, risk assessment, dose assessment, and closure design activities. The PM is responsible for the overall work scope, schedule, and budget.

Table 1. Key project responsibilities and responsible personnel.

Project Role	Responsible Official	Telephone Number
Project manager	Keith Quigley	526-3779
Environmental Affairs closure project manager	Susan Evans	526-0186
Operations manager	Frank Ward	526-3862
Project quality assurance officer	TBD[a]	
Job-site supervisor	TBD	
Field team leader	TBD	
Industrial hygienist	TBD	
Health and safety officer	TBD	
Radiological control technician	TBD	
Sampling team member[b]	TBD	
Laboratory manager	TBD	
Laboratory quality assurance officer	TBD	
Laboratory sample custodian	TBD	
Waste Generator Services – Waste Technical Specialist	TBD	
Data validation chemist	TBD	
Data quality assessment chemist/statistician	TBD	
Data storage administrator	High-Level Waste Program	

a. TBD = To be determined.

b. All sampling team members will be identified before sampling begins.

The PM is responsible for field activities and for all personnel (including craft personnel) assigned to work at the project location. The PM will serve as the interface between operations and project personnel and will work closely with the sampling team at the site to ensure that the objectives of the project are accomplished in a safe and efficient manner. The PM will work with all other identified project personnel to accomplish day-to-day operations at the site, identify and obtain additional resources needed at the site, and interact with the INTEC environment, safety, health, and quality (ESH&Q) oversight personnel on matters regarding health and safety.

2.2 Environmental Affairs Closure Project Manager

The Environmental Affairs (EA) closure project manager is responsible for regulatory oversight of the project. The EA Closure PM ensures that closure documentation complies with regulatory requirements and acts as the main resource for project communication to the independent Professional Engineer (PE) who certifies closure. Any deviation from the requirements specified in closure plan documentation will be communicated to the PE through the EA Closure PM.

2.3 Operations Manager

The TFF operations manager is responsible for all work that is accomplished in the facility. This includes ensuring that work activities are scheduled, adequate safety and health support personnel are available, and that the work performed is completed by personnel that are adequately trained to accomplish the work. The operations manager is a key function of the Integrated Safety Management System at the INEEL.

2.4 Project Quality Assurance Officer

The project quality assurance officer (PQAO) will report directly to INEEL management and will be organizationally independent for all WM-182 and WM-183 post-decontamination tank system characterization and closure activities. The PQAO also will be responsible for the control and implementation of all QA/QC actions conducted during post-decontamination characterization and subsequent closure activities.

These actions include:

- Conducting QA oversight of all reporting and all project data gathering efforts
- Conducting QA oversight for all laboratory analysis and data reporting
- Conducting QA oversight for all data validation and data evaluation
- Identifying and reporting any deviations from project QA objectives
- Identifying and implementing any necessary corrective actions
- Monitoring the performance of all field activities (sample collection, decontamination, and transport)
- Conducting system and performance audits, if necessary
- Preparing and submitting QA reports to management.

2.5 Job-Site Supervisor

The job-site supervisor (JSS) serves as the representative for the High-Level Waste (HLW) Program at the site. The JSS manages field activities, craft personnel, and other personnel assigned to work at the site. The JSS is the interface between operations and project personnel and works closely with the sampling team at the site to ensure that the objectives of the project are accomplished in a safe and efficient manner. The JSS and the PM will work together to accomplish day-to-day operations at the site, identify and obtain additional resources needed at the site, and interact with the health and safety officer (HSO), industrial hygienist (IH), and radiological control technician (RCT) on matters regarding health and safety. The JSS will be informed about any health and safety issues that arise at the site and may stop work at the site if an unsafe condition exists. The JSS will participate in all daily pre-job briefings. The duties of the JSS may be combined with the duties of the field team leader (FTL) and performed by one individual.

2.6 Field Team Leader

The FTL will be the INEEL representative at the site with responsibility for the safe and successful completion of sampling the post-decontamination WM-182 and WM-183 tank heels. The FTL works with the JSS, the RCT, and the field team to manage field sampling operations and to execute the SAP. The FTL enforces site control, documents activities, and may conduct the daily safety briefings at the start of the shift. Health and safety issues may be brought to the attention of the FTL. As previously stated, the duties of the FTL may be combined with the duties of the JSS and performed by one individual.

If the FTL leaves the site, an alternate will be appointed to act as the FTL. The identity of the acting FTL will be conveyed to site personnel, recorded in the FTL logbook, and communicated to the facility representative, when appropriate.

2.7 Industrial Hygienist

The IH is the primary source for information regarding hazardous and toxic agents at the site. The IH assesses the potential for worker exposures to hazardous agents according to applicable procedures, MCPs, and accepted industry IH practices and protocol. By participating in site characterization, the IH assesses and recommends appropriate hazard controls for the protection of site personnel and operates and maintains personnel sampling and monitoring equipment. The IH also recommends and assesses the use of personnel protective equipment in the health and safety plan (HASP) or other health and safety documentation such as safe work permits or radiological work permits.

In the event of a general area evacuation, the IH, in conjunction with other recovery team members, will assist the JSS and PM in determining whether or not conditions exist for safe site reentry. Personnel showing signs and symptoms of health effects resulting from possible exposure to hazardous agents will be referred to an Occupational Medical Program physician by the IH, the individual's supervisor, or the HSO. The IH may have other duties at the site as specified in other sections of the HASP, in PRDs, or MCPs. During emergencies involving hazardous materials, airborne sampling and monitoring results will be coordinated with members of the Emergency Response Organization.

2.8 Health and Safety Officer

The HSO is the person assigned to the site who serves as the primary contact for health and safety issues. A specific individual designated as the HSO may not be necessary because of the current health, safety, and radiological controls staff at INTEC. The PM will determine if an HSO is needed for this

project. The HSO advises the JSS and FTL on all aspects of health and safety. The HSO is authorized to stop work at the site if any operation threatens worker or public health or safety. The HSO is authorized to verify compliance with the HASP, conduct inspections, require and monitor corrective actions, and monitor decontamination procedures and require corrections, as appropriate. The HSO is supported by environment, safety and health (ES&H)/QA professionals at the INEEL (safety engineer, IH, RCT, radiological engineer, environmental coordinator, and facility representative) as necessary.

Persons assigned as the HSO (or as an acting HSO) must be qualified (in accordance with 29 CFR 1910.120(a)(3) [2001]) to recognize and evaluate hazards and will have the authority to take or direct actions to ensure that workers are protected. If the HSO must leave the site, an alternate, the IH, or the FTL will be appointed by the HSO as acting HSO. The identity of the acting HSO will be recorded in the appropriate logbooks, and site personnel will be notified.

2.9 Radiological Control Technician

The RCT is the primary source for information and guidance on radiological hazards and will be present at the site during all operations. Responsibilities of the RCT include radiological surveying of the site, equipment, and samples; providing guidance for radioactive decontamination of equipment and personnel; and, if significant radiological contamination occurs, accompanying any affected personnel to the nearest INEEL medical facility for evaluation. The RCT notifies the JSS of any radiological occurrence that must be reported as directed by PRD-183, "INEEL Radiological Control Manual," (INEEL 2000a). The RCT may have other duties at the site as specified in other sections of the HASP, in PRDs, or MCPs.

2.10 Sampling Team Members

The field team consists of the sampling team members, who are fully trained and skilled in the operation of the simple sampler, Light-Duty Utility Arm (LDUA), or other appropriate sampling equipment, a decontamination team, and the RCT. The sampling team members will be responsible for operating the sampling equipment, including collecting samples in sufficient numbers and volumes to meet the requirements presented in this SAP. The RCT will perform direct surveys of the sample chamber before it is detached and of the sample just before it is placed in the transport container or shipping cooler. The sampling team, under direct supervision of the HSO and the RCT, will be responsible for sampling equipment removal from the sampling area to a decontamination facility at the end of each sampling event. Decontamination of the sampling equipment will be performed according to a specific protocol, and a new, clean sampling chamber will be installed. The sampling team will then ensure that the sampling equipment is readied for the next sampling event according to the appropriate SOP.

Sampling team members must be experienced in operation of the simple sampler, LDUA, or other appropriate sampling equipment, and other aspects of sampling the TFF tanks as well as in requirements of INTEC and INEEL ES&H procedures and policies. Sampling personnel must also be familiar with the TFF systems and components.

2.11 Laboratory Manager

The laboratory manager will serve as the principal point-of-contact for coordinating laboratory activities. The responsibility of coordination with the field team may be delegated to a laboratory project manager within the laboratory organization. The laboratory manager will have ultimate responsibility for laboratory technical quality, cost control, and laboratory personnel management and for ensuring that the samples are analyzed and data reported on schedule.

2.12 Laboratory Quality Assurance Officer

The laboratory QA officer will evaluate all laboratory-generated data before it is released to determine if:

- Instrument calibrations were performed in accordance with the analytical statement of work (SOW) provided to the laboratory
- All method QC analyses comply with the requirements of the SOW and analytical methods
- The data-reporting format complies with the requirements stipulated by the project in the SOW.

The laboratory QA officer will notify the PM and the PQAO of all non-compliances and will seek immediate corrective action through the PQAO.

2.13 Laboratory Sample Custodian

The laboratory sample custodian (SC) will be responsible for maintaining sample custody, assigning laboratory identification numbers, and storing samples. To ensure compliance with project procedures, the SC will review all chain of custody (COC) forms, accompanying field radiological surveys, and all sample container identifications. In the event of field sampling or field radiological survey errors, the SC will notify the FTL and field team members of the error and seek to rectify the error immediately. All non-compliances will be documented in the laboratory logbook and copies provided to the laboratory QA officer and the PQAO to ensure that the appropriate corrective actions have been developed. Discrepancies in sampling documentation are documented in the COC or on a sample-receiving checklist, which becomes part of the data package.

2.14 Waste Generator Services – Waste Technical Specialist

The INEEL Waste Generator Services (WGS) waste technical specialist (WTS) will ensure disposition of non-sample waste material is in compliance with the approved HWMA/RCRA Closure Plan, Section 6 (DOE-ID 2001), and that applicable paperwork is completed. All samples and analysis wastes disposed by the INEEL Analytical Chemistry Laboratory will be disposed to the PEW evaporator system through normal routes or in accordance with INEEL MCP-2864, “Sample Management” (INEEL 1999a). The WGS WTS will ensure compliance with the applicable HWMA/RCRA requirements and PRD-166, “INTEC PEW Chemical Acceptance Criteria” (INEEL 1999b).

2.15 Data Validation Chemist

Data validation is one step of the data quality assessment (DQA) process. The data validation chemist performs analytical method data validation, which is the comparison of analytical results versus the requirements established by the analytical method. The validation involves evaluation of all sample-specific information generated from the point of sample collection to receipt of the final data package from the laboratory. Data validation is used to determine whether or not the analytical data are technically and legally defensible, reliable, and meet the DQOs of the project. Additional steps of the DQA process are discussed in Section 9.3.

The final product of the validation process is the validation report, which communicates the quality and usability of the data to the decision-makers. The validation report will contain an itemized discussion

of the validation process and results. Copies of the data forms, annotated by the data validation chemist for qualification of the data as discussed in the validation report, will be attached to the report.

2.16 Data Quality Assessment Chemist/Statistician

The DQA process is performed by one (or more) chemist/statistician familiar with analytical chemistry, statistical sampling designs, and statistical hypothesis testing. Steps of the DQA process involve data plotting, testing for outlying data points, and statistical hypothesis testing relative to the null and alternative hypotheses stated in the DQOs. The outcome of the DQA process is a statement that the statistical hypothesis testing suggests that the null hypothesis is accurate, that the null hypothesis has been rejected, or that not enough data exist to make a determinative conclusion based upon the hypothesis test used. In the latter case, either additional data must be collected to support the statistical hypothesis testing or the data user must make a decision with higher uncertainty than the levels expressed in the DQOs.

Data that are not necessarily invalid may be flagged during the data validation process. Flagged data are reviewed during the DQA process to determine whether the validation flags affect the intended use of the data. The determination of whether or not flagged data are used in statistical hypothesis testing is documented in the DQA report prepared by the DQA chemist/statistician.

2.17 Data Storage Administrator

The data storage administrator is responsible for maintenance of the HLW Administrative Record and Document Control (ARDC). The ARDC will be the official repository for all TFF closure project records. Upon completion of the WM-182 and WM-183 post-decontamination tank system characterization, the PM will transfer all hard-copy information and documentation developed from the project to the HLW Program ARDC for appropriate archiving. Hard-copy information and documentation include field logbooks, field and laboratory COC forms, laboratory reports and data, engineering calculations and drawings, final design reports, data validation reports, DQA reports, and all other technical reports related to the project. Copies of all analytical data and final reports will also be retained in the laboratory files, and at the discretion of the laboratory manager or QA officer, will be stored on computer disk and in hard-copy form for a minimum of five years from point of generation. Data will be made available for retrieval by authorized project staff from the HLW Program ARDC and the laboratory archives upon request.

3. QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The overall objective of the post-decontamination characterization is to obtain data to determine if decontamination activities have resulted in the TFF meeting the closure requirements as defined by HWMA/RCRA and DOE. DQOs are qualitative and quantitative statements derived from the first six steps of the EPA's DQO process (EPA 2000) that:

- Clarify the study objective
- Define the most appropriate type of data to collect
- Determine the most appropriate conditions from which to collect the data
- Specify tolerable limits on decision errors, which will be used as a basis for establishing the quantity and quality of data needed for decision-making.

3.1 Data Quality Objectives

DQOs are discussed in the context of the DQO process as defined by *Guidance for the Data Quality Objectives Process* (EPA 2000). This process was developed by EPA to ensure that the type, quantity, and quality of data used in decision-making are appropriate for the intended application. The DQO process includes seven steps, each of which has specific outputs. The DQO process has been, and will continue to be, used for each of the sampling activities conducted during the closure activities for Tanks WM-182 and WM-183. Each of the following subsections corresponds to a step in the DQO process, and the output for each step is provided as appropriate. Because sample collection will occur at various times during the closure activity, and the data use for each sample collection activity may vary, the outputs for each DQO step will reflect these data needs and uses.

3.1.1 Problem Statement

The first step in the DQO process is to clearly state the problem to be addressed in the context of the TFF HWMA/RCRA and DOE closure activities. The intent of this step is to clearly define the problem so that the focus of the activities will be unambiguous. The appropriate outputs for this step are (1) a concise description of the problem, (2) a list of the planning team members, (3) identification of the decision-maker(s), and (4) a summary of available resources and relevant deadlines for the study. The planning team members, decision-makers, and schedule are presented in the *Idaho Nuclear Technology and Engineering Center Tank Farm Facility Conceptual DOE and HWMA/RCRA Closure Approach* (INEEL 2000b) and in the *Tier 1 Closure Plan for the Tank Farm Facility* (Portage Environmental 2001a)[c]. The problem statement is that there is a need to demonstrate that tank decontamination activities have resulted in closure performance objectives being met.

Data collected will be used to determine if HWMA/RCRA action levels and DOE LLW facility closure performance standards (25 mrem/yr), which are consistent with performance standards in 10 CFR Part 61 (2001) Subpart C, are met. The residue remaining in the TFF following closure cannot be

c. Portage Environmental, Inc., 2001a, *Tier I Closure Plan for the Idaho Nuclear Engineering and Technology Center Tank Farm Facility at the INEEL*, INEEL/EXT-01-00576, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho (in print, expected January 2002).

characteristic hazardous waste (i.e., either characterized by toxicity or by corrosivity) 40 CFR 261 (2001). The concentration of hazardous constituents associated with the listed waste codes currently attached to the tank waste also must be below action levels. Data indicating that characteristic waste remains in any given tank, vault sump, DVB, or cooling coil, or that concentrations of hazardous constituents are above HWMA/RCRA Closure Plan action levels (DOE-ID 2001) may be used to justify additional removal and decontamination. Following the closure of all TFF tank systems, the mean concentrations for constituents remaining in the residuals in all tanks, vault sumps, and DVBs will be used to determine if the clean-closure specifications stated in the closure plan have been met or if closure to alternative DOE requirements for HLW facilities and/or HWMA/RCRA landfill standards will be required.

3.1.2 Decision Statement

The second step in the DQO process is to identify the decisions and the potential actions that will be affected by the data collected. This is done by specifying principal study questions (PSQs) and alternative actions (AAs) that could result from resolution of the PSQs, and by combining the PSQs and AAs into decision statements.

The objective of the post-decontamination tank system sampling is to answer the following PSQ:

- Are post-decontamination concentrations of radioactive and hazardous constituents remaining in the TFF less than the applicable performance assessment standards and action levels specified in the HWMA/RCRA Closure Plan (DOE-ID 2001a)

The AAs to be taken depending on the resolution of the PSQ are as follows:

- If the concentration of any radioactive or hazardous constituent in any individual tank system component (e.g., the WM-182 or WM-183 tanks, cooling coils, vault sumps, and/or DVB) results in a large enough contribution to the mean concentration of the constituent for the TFF as a whole such that an action level specified in the closure plan for the TFF has been exceeded, then additional decontamination of the most contaminated tank system components will be considered

- If the concentration of any hazardous constituent or the pH of the solution remaining in any individual tank system component (e.g., the WM-182 or WM-183 tanks, vault sumps, and/or DVB) results in the solution being a characteristic hazardous waste due to the toxicity or corrosivity characteristic, then additional decontamination of the tank will be accomplished until the hazardous characteristic has been removed

- If the concentrations of radionuclides indicate that the DOE Order 435.1 performance standards have been met, the tank system will be closed as a LLW landfill

- If the concentrations of hazardous constituents indicate that the closure performance standards have been met, then the TFF will be closed under a HWMA/RCRA clean closure

- If additional decontamination is not deemed feasible and concentrations of hazardous constituents and/or radionuclides indicate that the performance standards for the residuals in the TFF have not been met, then closure to HWMA/RCRA landfill standards or alternate requirements consistent with DOE Order 435.1 will be implemented as applicable.

Combining the PSQ and AAs results in the following decision statement:

- Determine if decontamination of the TFF tank systems has resulted in concentrations of constituents or properties (i.e., pH) of concern in the residuals remaining in the TFF system components being below closure performance standards; if not, then HWMA/RCRA landfill standards and/or alternate DOE requirements for closure must be met.

3.1.3 Decision Inputs

The third step in the DQO process is to identify the informational inputs required to resolve the decision statement and to determine which of those inputs require measurements. The informational input needed to resolve the decision statement in Section 3.1.2 is the identification and quantification of hazardous and radioactive constituents present in each of the tank systems following decontamination.

A determination of whether or not to continue decontamination activities will be based on achievement of the performance standards stated in the closure plan and direct comparison to the radionuclide source term used in the PA (see footnote b, page 2). Decontamination operations at WM-182 and WM-183 will cease when characterization data show that (1) the mean concentrations of hazardous constituents remaining in the tanks, vault sumps, and DVB-C6 are below the action levels specified in the closure plan, (2) the chromium remaining in the cooling coils is reduced to concentrations below the action level for chromium specified in the closure plan, (3) radionuclide activities provide acceptable results when used as the PA source term.

Clean-closure action levels for HWMA/RCRA are defined in Section 3 of the HWMA/RCRA Closure Plan (DOE-ID 2001a). The PA used the known source term, and action levels for each radionuclide have been established. Even if the post-decontamination characterization data show that the performance standard for an individual radionuclide has not been met, the results of the PA modeling could remain acceptable based on the reduction of other radionuclides to levels well below the action levels used in the PA. Because of this, data collected during post-decontamination characterization will be used in the PA model to determine whether or not decontamination has met PA action levels. All of the data collected during TFF closure operations are required before PA action levels can be assessed. Therefore, no final decisions regarding the radionuclide concentrations can be made as a result of collection of data following decontamination of *only* the WM-182 and WM-183 tanks and vaults.

To resolve the decision statement, concentrations of the hazardous constituents and radionuclides remaining in all of the TFF tank systems must be determined. Data on the concentrations of constituents currently in the tanks are available. The existing data, PA source term, and key radionuclides listed in DOE Order 435.1 are relevant to this study because they provide a list of constituents for which analyses should be performed. The existing data also can be used to provide estimates of contaminant concentration variability within the tanks. However, the existing data cannot be used to determine whether closure performance standards have been met as the data were collected before decontamination. The existing data are summarized in Section 3.2. Information from process knowledge of tank operations further defines the list of constituents for which analytical data are required following decontamination.

During this third step of the DQO process, the basis for an action level is established. The action level is the threshold value that provides the criterion for choosing among AAs. Action levels are derived from risk assessment methodologies. The constituent-specific action levels were derived to ensure the protection of human health and the environment. For hazardous constituents, a description of how the action levels were derived is provided in Appendix C of the HWMA/RCRA Closure Plan (DOE-ID 2001a). Radioactive constituents will be modeled to ensure the PA criteria are met. The PA will assume a

groundwater exposure pathway, an air exposure pathway, and an intruder analysis. The PA requires exposure to the public of less than 25 mrem/yr.

The radioactive constituents are evaluated using exposure pathways to determine appropriate clean-closure definitions. The PA must present valid conclusions that demonstrate that all pathways (air pathway, groundwater resource protection, and the inadvertent intruder analyses) meet the performance objectives or measures of DOE Manual 435.1-1 (DOE 2001b) (see Section 3.1.3, Criterion 1). The objective of the PA is to establish the basis for concluding the reasonable expectation of facility performance and to provide reasonable assurance the performance objectives will be met at the disposal facility.

3.1.4 Study Boundaries

The fourth step in the DQO process is to define the spatial and temporal boundaries of the study. The spatial boundaries define the physical extent of the study area; they may be subdivided into specific areas of interest. The temporal boundaries define the duration of the entire study or specific parts of the study. The appropriate outputs of this step are a detailed description of the spatial and temporal boundaries of the problem and a discussion of any practical constraints that may interfere with the study.

The HWMA/RCRA facility closure requirements specify that the boundaries applicable to cleanup of closed facilities are the unit boundary of the unit being closed. The boundaries for DOE HLW facility closures are based on the PA conducted during closure activities. For this sampling effort, the TFF is divided into five general sampling locations: the tank heel residuals, the residual contents of the tank vault sumps, residual contents of the DVB-C6 sump, rinsates collected from sections of waste transfer lines that have been removed from the system, and the residual contents of the decontaminated cooling coils. The sampling and analyses of the waste transfer piping is covered under the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the Process Waste Lines from INTEC Tank Farm Facility Tanks WM-182 and WM-183* (INEEL 2001).

The media to be sampled to resolve the decision statement are representative portions of the rinse solutions remaining in the tanks, vault sumps, the DVB-C6 sump, and cooling coils following decontamination activities. To characterize these residuals, samples from the various locations will be collected and analyzed. The data from the analysis of samples of the residuals remaining in the tanks will be compared to the data from analysis of samples collected from the sumps to determine if there is evidence that the two sampled populations (i.e., tank residuals and sump residuals) are statistically different populations. If it is determined that the residuals in the sumps are statistically different than the residuals in the tanks, then the action levels will be assessed separately for the two populations. That is, the mean concentrations of contaminants from sample locations that have been determined to be different will be compared to the action levels. If the residuals in the sumps and tanks are determined to be statistically the same, then the mean concentrations for the entire data set will be used to assess whether or not action levels were exceeded.

Closure of the TFF will be based on the mean characteristics when all tank systems at the TFF have had the waste removed and decontamination completed. Similar populations will be compared using a t-Test analysis (or other appropriate statistical method) to compare mean concentrations in the two populations. As stated earlier, the rinsates from the cooling coils will be sampled to determine the mean concentration of chromium to determine if the action level specified in the HWMA/RCRA Closure Plan has been exceeded. The rinsate data from the cooling coils will not be used to determine the mean concentrations of constituents in the TFF.

Defining the temporal boundaries of the problem involves specifying the timeframe to which the decision applies and determining when to collect data. Closure of the TFF requires that any constituents left in place will have no adverse impacts to human health and the environment at any future date. Subsequently, decisions made at the time of closure also must apply to any future date. Because of the length of time involved, it will not be possible to collect data over this entire period. Therefore, the performance standards applied to this closure will model impacts to the environment and public radiation exposure from the tank residuals left in place. The data collected after decontamination activities are completed at each individual tank, vault sump, and DVB-C6 associated with closure of WM-182 and WM-183 will be combined with data from the other TFF tanks, vault sumps, and DVBs to conduct this risk assessment. The period within which to collect the data is determined by decontamination operations, and these operations will continue at any given tank, sump, or DVB until project personnel believe the decontamination is complete. At that time, one sample from the tank or vault sump may be collected and the data compared to the action levels. If the data from this initial sample are in a range where project personnel feel that the sampling required to meet the DQOs can commence, the samples specified in this SAP will be collected.

In defining the study boundaries, the scale of decision-making must also be discussed. As discussed previously, the performance standards will be applied to the effects of exposure to the public by leaving tank system residuals in place. Thus, to assess DOE closure requirements, the model used in the PA (see footnote b, page 2) will drive the scale of decision-making. For HWMA/RCRA closure, the decisions will apply to closure of the TFF as it is defined in the HWMA/RCRA Closure Plan.

The practical constraints on data collection include the difficulties in obtaining samples from the tanks and vault sumps (specifically, limited access and the potential for high radiation fields). Several options for obtaining representative samples and/or obtaining data to characterize the contents will be investigated including:

- Using a radiation detection device to monitor tank discharges during decontamination and determine the appropriate times to collect samples using the simple sampler, LDUA, or other appropriate sampling equipment. The data gathered from the beta/gamma detection equipment during decontamination of Tanks WM-182 and WM-183 could also be used to determine when variability of the remaining tank contents becomes low enough to minimize the number of samples collected in future tank decontamination activities and when to collect the initial sample, discussed previously. The data from the final samples collected can be used to verify variability indicated by the radiation detection equipment.

- Collecting samples from the tanks through riser assemblies with the simple sampler, LDUA, or other appropriate sampling equipment.

- Collecting samples of rinse solutions from the cooling coils using existing sample collection ports installed in these lines.

- Collecting samples from the tank vault sumps using remote sampling equipment.

- Collecting samples of rinse solutions from DVB-C6 using remote sampling equipment.

The sample collection option (or options) will be chosen that provides the most representative characterization of the sample populations while adequately protecting the health and safety of sampling team members. Limitations on data interpretation introduced by sample collection constraints (e.g., inadequate ability to collect samples from the randomly selected sample locations and inability to collect sufficient sample volume) will be discussed in the closure activity summary reports.

3.1.5 Decision Rule

The fifth step in the DQO process is to (1) define the parameters of interest that characterize the population, (2) specify the action level, and (3) integrate previous DQO outputs into a single statement that defines the conditions that would cause the decision-maker to choose among AAs. The decision rule typically takes the form of one or more "If…then" statements describing the action or actions to take if one or more conditions are met.

The decision rule must be specified in relation to a parameter that characterizes the population of interest. Because agitation of the tank residues will occur during decontamination activities, it is assumed that residual contaminants will be relatively equally distributed. It is also assumed that final rinse solutions from the tank system cooling coils will be relatively homogenous aqueous solutions with low concentrations of contaminants of concern. Therefore, the parameter of interest will be the true mean concentration of the contaminants of concern. Because it is not possible to determine the value of the true mean using sample data, a statistic must be chosen upon which the actions are based. In the case of closure of the TFF, the true mean will be estimated by the concentration at the 95% upper confidence limit (UCL) of the sample mean.

The decision rules are based on the HWMA/RCRA Closure Plan requirements that specify that neither hazardous, Class C, greater than Class C, nor transuranic (TRU) waste may be left in place following closure and that the risks posed by the concentrations of measurable contaminants are acceptable. Therefore, the decision rules are

- *If* the true mean (as estimated by the 95% UCL of the sample mean) concentration of any applicable hazardous waste constituent detected in toxicity characteristic leaching procedure (TCLP) analyses of the TFF residuals collected from any individual tank, vault sump, or DVB-C6 is greater than the maximum concentration of contaminants for the toxicity characteristic listed in 40 CFR 261.24, or *If* the true mean pH (as estimated by the 5% lower confidence limit of the sample mean for acid pH and the 95% UCL of the sample mean for basic pH) of TFF residuals collected from any individual tank or vault sump exhibit the characteristic of corrosivity, *then* either additional decontamination steps will be undertaken or closure to HWMA/RCRA landfill standards will be considered.

- *If* the true mean (as estimated by the 95% UCL of the sample mean) concentration of any hazardous constituent detected in total constituent analyses of the TFF residuals collected from statistically similar populations (i.e., sample locations) is greater than the action level specified in the closure plan, *then* additional decontamination steps may be undertaken. Closure to HWMA/RCRA landfill standards will be considered at final closure of the TFF.

- *If* the true mean (as estimated by the 95% UCL of the sample mean) concentration for the sum of the radioisotopes in any given tank system at the time the samples are collected is not indicative of Class C waste as defined in 10 CFR 61.55 (2001), *then* residual radionuclide concentration will be averaged with the mass of grout needed to enhance waste removal and stabilization.

- *If* the true mean (as estimated by the 95% UCL of the sample mean) concentration for the sum of the radioisotopes in any given tank system at the time the samples are collected is indicative of Class C waste as defined in 10 CFR 61.55 (2001), *then* for safety and technological reasons grout will be added to the Class C waste to eliminate free liquids, resulting in a waste form that meets performance standards for LLW as defined in DOE Order 435.1 (DOE 2001a).

- *If* the true mean (as estimated by the 95% UCL of the sample mean) concentration for the sum of the TRU radioisotopes detected in the analyses of the residuals in any tank or vault sump is greater than 100 nCi/g, *then* additional waste removal and/or decontamination may be performed or stabilization of the residuals in accordance with Chapter III of DOE Guide 435.1-1 (DOE 1999) will be performed.

3.1.6 Decision Error Limits

The sixth step in the DQO process is to minimize uncertainty in the data by specifying tolerable limits on decision errors. The limits are used to establish performance goals for the data collection design. The possible range for the parameter of interest is determined, and the types of decision errors and the potential consequences of the errors are defined.

Decisions are based on measurement data; however, the data provide only an estimate of the true state of the waste. Because of this, decisions could be based on data that may not accurately reflect the true state of the TFF residuals. Therefore, if the data are not a true representation of the characteristics of the tank system residuals, the decision-maker could make a decision error. The decision-maker must define tolerable limits on the probability of making a decision error.

The probability of a decision error can be controlled by adopting a scientific approach. Using this approach, the data are used to select between the presumed condition of the decontaminated tank system residuals and the alternative condition. One of these conditions is assumed to be the baseline condition and is referred to as the *null hypothesis* (H_0). The alternative condition is referred to as the *alternative hypothesis* (H_a). The null hypothesis is presumed to be true in the absence of strong evidence to the contrary. This feature provides a way for the decision-makers to guard against making the decision error with the most undesirable consequences.

A decision error occurs when the decision-maker rejects the null hypothesis when it is true (a *false positive decision error)* or fails to reject the null hypothesis when it is false (a *false negative decision error*). For example, a decision-maker presumes a certain waste is hazardous (i.e., the null hypothesis is "the waste is hazardous"). However, if the data on that waste cause the decision-maker to conclude that the waste is not hazardous when it really is hazardous, then the decision-maker would make a false positive decision error. Statisticians usually refer to this as a Type I error. The size of this error is called alpha (α), the level of significance, or the size of the critical region.

A false negative decision error occurs when the decision-maker fails to reject the null hypothesis when it is false. In the waste example given above, the false negative decision would be to use the data to conclude that the waste is hazardous, when in fact it is not. Statisticians usually refer to false negative decision errors as Type II errors. The measure of the size of this error is called beta (β), and the measure is also known as the compliment of the power of a hypothesis test.

The possibility of decision error cannot be eliminated, however, by controlling the total study error, it can be minimized. Methods for controlling total study error include (1) collecting a large number of samples (to control sampling design error), (2) analyzing individual samples several times, or (3) analyzing individual samples using more precise analytical methods (to control measurement error). The chosen method for reducing decision errors depends on where the largest components of total study error exist in the data set and the ease in reducing error in those data components. The amount of effort expended on controlling decision error is directly proportional to the consequences of making an error.

The two types of decision error for the characterization of decontamination residuals for the TFF and for the WM-182 and WM-183 tanks systems are determining that the concentration(s) of constituents

in the residuals do not exceed action levels when in fact they do or determining that the concentration(s) of constituents in the residuals exceed action levels when they in fact do not. The consequences of each decision error must be considered. Concluding that the residuals meet action levels, when in fact they do not, would result in the assumption that the TFF could be clean closed under HWMA/RCRA and the facility could be closed under DOE 435.1 action levels. The consequences of this error would be fewer controls in place to ensure protection of the public and the environment following closure when, in fact, these controls should be in place. Concluding that the residuals do not meet performance standards, when in fact they do, would result in either additional decontamination activities or proceeding with closure to HWMA/RCRA landfill standards and/or applicable DOE requirements. The consequences of this decision would be further expense of project resources to complete the additional activities, issues associated with the project schedule being unnecessarily lengthened, and the potential for generation of unnecessary waste in the form of additional rinsate solutions as further decontamination is attempted.

The decision error that has the more severe consequences as the true concentrations of the parameters of interest approach the action level must be specified. In problems that concern regulatory compliance, human health, or environmental risk, the decision error that has the most adverse consequences is established as the null hypothesis. The decision error with the more severe consequences is used because, as the parameters approach the action level, the data are much more likely to lead to an incorrect decision than when the parameters are far above or below the action level. In statistical hypothesis testing, the data must conclusively demonstrate that the null hypothesis is false, which places the burden of proof on demonstrating that the most adverse consequences will not be likely to occur.

Because the more severe decision error occurs when it is determined that the concentration of constituents in the tank system residuals are less than action levels when in fact they are not, the null hypothesis will be set as, “The concentration of hazardous or radioactive constituents in TFF residuals following decontamination exceed action levels.” The alternative hypothesis then becomes, “The concentration of hazardous or radioactive constituents in TFF residuals following decontamination are less than action levels.”

Based on these definitions of the null and alternative hypotheses, the false positive and false negative errors can be stated. The false positive decision error corresponds to the more severe decision error. The false positive error would be to conclude that the concentration of hazardous or radioactive constituents in TFF residuals following decontamination are less than action levels when, in fact, they are not. The false negative decision error would be to conclude that the concentration of hazardous or radioactive constituents in TFF residuals following decontamination are greater than action levels when, in fact, they are less.

A range of possible parameter values must be specified where the consequences of decision errors are relatively minor. This range of parameter values is referred to as the “gray region.” The gray region is bounded on one side by the action level and on the other side by the parameter value where making a false negative decision error begins to be significant. It is necessary to specify the gray region because the variability in the population and unavoidable imprecision in the measurement system combine to produce variability in the data such that a decision may be “too close to call” when the true parameter value is very close to the action level. In statistics, this interval is called the “minimum detectable difference” and is expressed with the Greek letter delta ( ). The width of this gray region is a critical part of the calculation for determining the number of samples needed to satisfy the DQOs, and it represents one important aspect of the decision-maker’s concern for decision errors. A narrower gray region implies a desire to detect conclusively the condition when the true parameter value is close to the action level. From a practical standpoint, the gray region is an area where it will not be feasible to limit the false negative decision error rate to low levels because of high costs.

However, because the costs associated with making a false negative decision error are relatively high for this closure activity, a narrow gray region will be appropriate. The gray region will be as follows:

- For characteristic hazardous waste determinations, the gray region will be bounded on one side by the TCLP maximum concentration for the toxicity characteristic and on the other side by a value that is 80% of the parameter-specific maximum concentration

- For measuring the waste for the corrosivity characteristic, the gray region will be bounded on one side by a pH measurement of 2.0 (or 12.0) and on the other side by a pH measurement of 1.6 (or 12.4)

- For other hazardous constituents of concern in the waste, the gray region will be established between 80% and 100% of the action levels for the hazardous constituents as specified in the HWMA/RCRA Closure Plan (DOE-ID 2001a)

- For the determination of TRU waste, the gray region will be established between 80 and 100 nCi/g total activity for the radionuclides with an atomic number greater than 92 and a half-life greater than 10 years

- For Class C and greater than Class C determinations, the gray region will be established between the criteria in 10 CFR 61 (2001) and 80% of these criteria.

The final activity required in specifying the tolerable limits on decision error is to assign limits to points above and below the gray region that reflect the probability of occurrence of decision errors. These probability values are the decision-maker's tolerable limits for making an incorrect decision when the parameter of interest (in this case the true mean concentration) is equal to a concentration at the action limit or at the lower boundary of the gray region. Selection of the tolerable limits is done by choosing a possible true value for the parameter of interest and then choosing a probability limit based on an evaluation of the seriousness of the potential consequences of making a decision error if the true parameter value is located at that point. The EPA guidance (EPA 2000) recommends beginning the evaluation of sampling designs using 1% (a value of 0.01) as the starting point for setting decision error rates. The guidance specifies that the value of 0.01 should not be considered a prescriptive value for setting decision error rates, nor be considered policy of EPA. Rather, it should be viewed as a starting point from which to develop decision errors applicable to the study. A graphic demonstration of these concepts is presented in Figure 1.

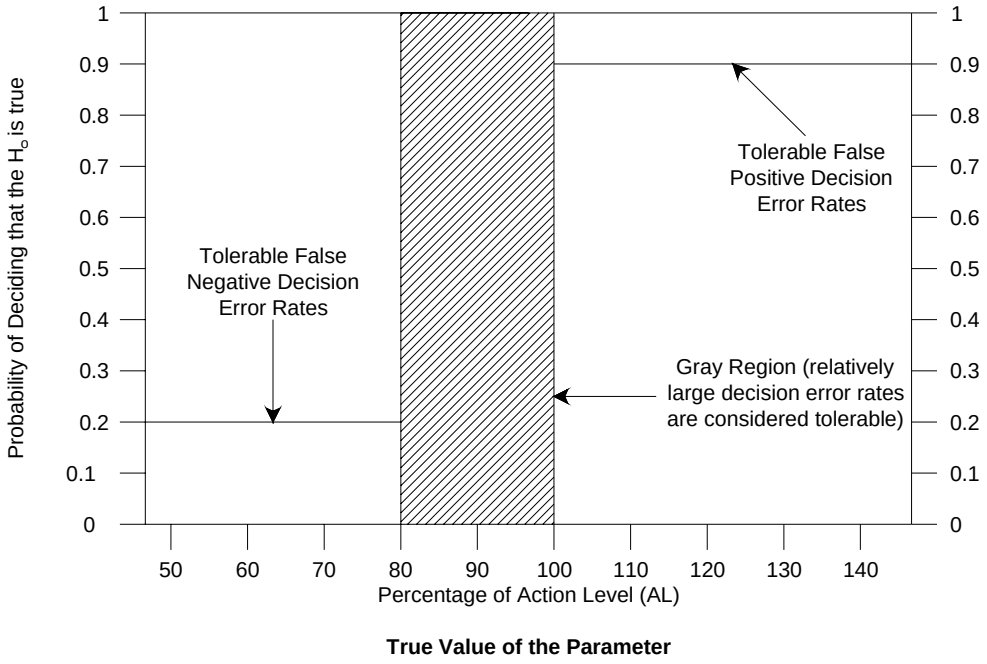
The project team must use the three variables (width of gray region, acceptable false positive decision error rate when the true mean is equal to the action level, and acceptable false negative decision error rate when the true mean is equal to the lower bound of the gray region) and adjust them to acceptable tolerances. Once this has been done, the number of samples required to satisfy the DQOs and the sample collection design can be determined.

3.1.7 Design Optimization

The last step in the DQO process is design optimization. The purpose of design optimization is to identify the best sampling and analysis design that satisfies all of the previous steps in the process. The activities involved in design optimization include:

- Reviewing the outputs of the first six steps and existing environmental data

- Developing general data collection design alternatives



Baseline condition: Parameter exceeds action levels.

True Concentration	Correct Decision	Type of Error	Tolerable Probability of Incorrect Decision
<80% AL	Not exceed	F(-)	20%
80 to 100% AL	Not exceed	F(-)	Gray region
>100% AL	Does exceed	F(+)	10%

Figure 1. Example of a decision performance goal diagram and corresponding decision error limits table.

- Formulating a mathematical expression needed to solve the design problem for each data collection design alternative
- Selecting the optimal number of samples to satisfy the DQOs for each data collection design alternative
- Selecting the most resource-effective data collection design that satisfies all the DQOs.

After these activities are completed, the operational details and theoretical assumption of the selected design are documented in the SAP.

The outputs of the first five steps have been discussed previously. Environmental data are available for the WM-182 and WM-183 tank system contents before decontamination activities began. However, these data cannot be used to develop information concerning the possible range of concentrations (or values) that will be measured for the constituents (and property) of interest. As no data exist for characterization of tank contents following decontamination activities, only assumptions of parameter variability and possible concentration ranges can be made.

Because of the difficulty in obtaining samples from the tank, data-collection design alternatives are limited. The planning assumptions for the project include some assumptions related to sample collection. Specifically, the assumption has been made that the samples of post-decontamination residuals in the tank heel, vault sump, and DVB-C6 sump, collected through the riser assemblies using the simple sampler, LDUA, or other grab sampling techniques, will be representative of the tank system contents. That is, if only a liquid phase is obtained using these techniques, the solid phase is assumed inconsequential and can be ignored. If solid phase is obtained, it will be segregated and analyzed separately by the laboratory. For the residuals in the tank heel, if solids exceed 15% by volume of the total sample collected at a given location (see discussion in Section 5.1.2), sub samples of the solids will be separated and analyzed. Because samples can only be collected through the risers, the reach of the LDUA is a 13.5-ft radius from the only riser it can be lowered through in each tank, and the simple sampler has no reach away from a location directly beneath the three risers it can be lowered through in each tank, a truly random sampling design based on all locations in the bottom of the tank having an equal opportunity of being sampled is not possible.

For the vault and DVB-C6 sump contents, a sample that consists of a large proportion of these sumps will be collected. This sample will provide for a good estimate because of the size of sample collected relative to the total size of the sampled population. It is estimated that the vault and DVB-C6 sumps will contain less than 7.4 gal of rinsate following decontamination activities. The vault sumps and DVB contain piping that will make it difficult to collect large volumes of sample. Therefore, only one sample will be collected for the required analyses from each of the two vault sumps in each tank vault and the DVB-C6 sump. For the cooling coils, because all coils can be sampled, a random sample design can be applied. Sampling and analysis of the waste transfer lines is covered under the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the Process Waste Lines from INTEC Tank Farm Facility Tanks WM-182 and WM-183* (INEEL 2001a).

Because the volume of residual liquid remaining in the system will be greatest in the tanks, the greatest potential for risk from the presence of constituents following decontamination exists in the decontaminated tanks. Because of this, it is important to apply a very defensible sampling design to the post-decontamination residuals in the tank heels. For the application of statistical hypothesis testing formulas, the sampling design will be simple random sampling. Despite the limitations described, a simple random sampling design can be applied to the tank residuals. Simple random sampling is a type of sampling where every point in the population has an equal chance of being selected. Simple random sample designs are chosen when the variability of the medium is relatively small and sufficient resources are available to conduct the required number of analyses. Because the sampled populations will be agitated during decontamination activities, the possibility of "every point in the sample medium having an equal opportunity of being selected" is valid. The assumption of random sampling statistics is therefore valid for characterization of the liquid phase present in the tanks and for rinsate solutions following decontamination of the cooling coils. These solutions will be aqueous-based liquids, which tend to be relatively homogeneous (assuming no solids content in the samples collected). Therefore, the sample collection points accessible through the risers, the vault sump, and the DVB-C6 access ports, and from the sample collection ports in the cooling coils are just as likely to obtain a random sample as any other sample collection point. In the case of the tank vault and DVB-C6 sumps, statistical hypothesis testing will not be applied because the samples will represent such a large proportion of the entire population, and the analysis results will be very close to any sample mean that would be determined if multiple analyses were possible. That is, the values obtained from single measurements from samples from these locations will be used.

The sampling design that will be used for the tank residuals and cooling coils is stratified random sampling. Stratified random sampling uses a random sampling approach within each of the two strata sample location types (i.e., tanks and cooling coil sets). Two data-collection design alternatives can be

followed for using a random sampling approach within sample location types: simple random sampling or composite random sampling. In simple random sampling, several locations are randomly chosen and separate samples are collected and analyzed from each. In composite random sampling, multiple samples are collected and physically combined (composited) and one or more sub-samples are drawn for analysis. Because of the nature of the sample collection logistics and personnel safety concerns, it is likely that composite sampling will not be an acceptable alternative for sampling the TFF tanks system components. Therefore, the option of composite random sampling is not considered further.

Another sampling approach to be considered is systematic sampling, which is usually the method of choice when estimating trends or patterns of contaminants over space or time. Systematic sampling also is useful in estimating the mean concentration when trends and patterns in concentration are not present, or are known *a priori,* or when strictly random methods are impractical. In systematic sampling, samples are taken at locations and/or times according to a spatial or temporal pattern (for example, at equidistant intervals along a line or within a grid pattern). The inaccessibility of some portions of the tanks would make this approach difficult to implement in this activity. However, the use of a temporally systematic approach may be beneficial for the real-time radiation measurements taken as the decontamination activities proceed.

Commonly accepted mathematical expressions are used to solve the design problems for a simple random sampling approach. A mathematical expression is used to test the statistical hypothesis and define the formula for determining the number of samples required with the chosen design alternative. In some cases, a reliable estimate of the population variance is not available for determining the number of samples. This activity presents such a case. However, in such cases, an estimate of the relative standard deviation (coefficient of variation [CV]) is used. The approach is to use the relative error formula, Equation (1), to solve for error probability, as shown in Equation (2).

$$d_r d_r^2 = \left| \bar{x} - \mu \right| / \mu \tag{1}$$

$$\text{Prob} \left[\left| \bar{x} - \mu \right| \right] \geq d_r \mu = \alpha \tag{2}$$

where:

0 = sample mean

μ = population mean

d_r = relative error

α = false positive value.

The formula for computing the number of samples required for a simple random sampling approach is shown in Equation (3).

$$n = (Z_{1-\alpha/2}\eta / d_r)^2 \tag{3}$$

where:

n = number of samples required

Z_p = the p^{th} percentile of the standard normal distribution (from statistical tables)

η = coefficient of variation (CV) or σ/μ

d_r = relative error or the absolute value of the difference of the sample mean and population mean, which is then divided by the population mean

σ = population standard deviation

μ = population mean.

As it is assumed that the variability of the liquid matrix will be low (it will be relatively homogeneous throughout the volume remaining in the tank and cooling coils), a low CV can be chosen. Therefore, a CV of 20 is used, and the assumption is made that it is acceptable to have a 10% chance of getting a set of data for which the relative error exceeds 15%. Hence $d_r = 0.15$ and $Z_{1-0.10/2} = 1.645$ and $\eta = 0.20$. An example of how the number of samples is derived, using these variables, is given in Equation (4).

$$n = \left[\frac{1.645(0.20)}{0.15}\right]^2 = 4.8 \quad (4)$$

Solid material recovered during sampling is likely to be more variable. The number of solid samples should be increased using an assumption of this variability. If it is accepted that agitation of the solid during decontamination activities will result in the solids being as homogeneous as the liquid matrix, then five samples would suffice in meeting the project DQOs for this matrix also.

Another method for calculating the appropriate number of samples to collect uses estimates for the variability of the sampled matrices, acceptable decision error rates, and the width of the gray region.

To meet these DQO requirements, the number of samples required for each analyte must be determined before sampling takes place. It is assumed that the samples will be taken via simple random sampling. To calculate the number of samples to collect (i.e., the sample size), the following must be known:

- Size of the minimum detectable region (Δ)
- Standard deviation of the concentration of the analyte (σ)
- Chance of making a false positive decision error (α)
- The chance of making a false negative decision error (β).

These quantities are defined in Section 3.1.6. It is assumed that a minimum detectable difference, or gray region, for the TFF sampling that is bounded by the action level on one side and 80% of the action level on the other side will be acceptable. Using this assumption, the value of $\Delta = 0.20$. It is not known what the standard deviation (σ) will be for any constituent once the tanks are cleaned, so a conservative estimate of 10% of the action level will be used. Given these values for Δ and σ, calculations can be used to examine the sample size for various values of α and β. Table 2 provides the sample size estimates for various values of the chance of false positive error (α) and the chance of false negative error (β). Assuming a simple random sample is being taken, the formula used to calculate the sample size is shown in Equation (5).

Table 2. Required sample size (n) associated with various false negative error rates (β) and false positive error rates (α) when σ = 10% of the action level and the width of the gray region is from 80% to 100% of the action level (i.e., Δ = 0.20).

α	β	n	α	β	n
0.01	0.01	8.12	0.05	0.01	5.30
	0.05	6.65		0.05	4.06
	0.10	5.96		0.10	3.49
	0.15	5.53		0.15	3.15
	0.20	5.21		0.20	2.90
	0.25	4.96		0.25	2.70
	0.30	4.74		0.30	2.53
	0.35	4.54		0.35	2.38
0.075	0.01	4.58	0.10	0.01	4.08
	0.05	3.41		0.05	2.96
	0.10	2.89		0.10	2.46
	0.15	2.57		0.15	2.16
	0.20	2.34		0.20	1.95
	0.25	2.15		0.25	1.78
	0.30	2.00		0.30	1.64
	0.35	1.87		0.35	1.52
0.15	0.01	3.36	0.20	0.01	2.86
	0.05	2.33		0.05	1.90
	0.10	1.88		0.10	1.48
	0.15	1.61		0.15	1.24
	0.20	1.42		0.20	1.06
	0.25	1.27		0.25	0.93
	0.30	1.15		0.30	0.82
	0.35	1.04		0.35	0.73

$$n = \frac{\left(z_{1-\alpha} + z_{1-\beta}\right)^2 \sigma^2}{\Delta^2} + \frac{1}{2} z_{1-\alpha}^2 \tag{5}$$

where:

α = false positive rate

β = false negative rate

σ = estimated standard deviation of the population

Δ = minimum detectable difference

z_x = the x^{th} quantile of the standard normal distribution.

Using this equation and Table 2, it becomes apparent that, if the assumption concerning data variability holds, the sample size proposed (i.e., five samples) will allow an assessment of the null hypothesis with a 5% false positive decision error rate and a 5% false negative decision error rate. Alternatively, the same sample size could give a false positive decision error rate of 1% if a false negative error rate of 25% is more desirable. Therefore, for this sampling activity, a sample size five (5) will be used for the tank heels and as the number of cooling coils from each tank from which a sample will be collected to estimate the mean concentration of chromium remaining in all of the coils.

3.2 Presentation and Evaluation of Initial Characterization Data

The following sections summarize the detectable concentrations of potential contaminants of concern and measurable radionuclide activity in the heels of the WM-182 and WM-183 tanks. These data are from samples collected in 1999 and 2000. The data represents the tank heels only, and no samples have been collected from the vault sumps, DVB-C6, or cooling coils. Several organic compounds were detected in the heels of both tanks, and a significant number of detections were made for radionuclide activity and target metals. For the purposes of evaluating the sample data, all sample results for analytes reported as not being detected have been eliminated from the data summary so that existing site conditions can be reviewed and evaluated without having to review all available data.

3.2.1 Summary of Organic Compound Detections

Several organic compounds were detected in the heels of both Tanks WM-182 and WM-183 as shown in Table 3. Most of the organic compounds detected are generally consistent with the waste materials that were expected to contribute contaminants of concern to the tank heels.

Several liquid samples and one solid sample were taken from Tank WM-182, and several solid and liquid samples were taken from Tank WM-183. Due to the natural breakdown of hexanone, all the detected ketones must be considered when evaluating potential contaminants of concern for closure purposes. Detections of the ketones 2-hexanone, 2-butanone, 4-methyl-2-pentanone, and acetone correlate to the extensive use of hexanone as a process solvent/extractant and its degradation within both Tanks WM-182 and WM-183.

In the samples from Tank WM-182, all four of the ketones were detected. In the solid sample, 2-hexanone was detected. In the liquid samples, acetone was detected five times, 2-butanone was detected three times, 4-methyl-2-pentanone was detected two times, and 2-hexanone was detected once. Of the four ketones of concern, acetone was detected most often and at concentrations above 100 µg/L (see Table 2). The only ketone detected in the Tank WM-183 samples was acetone; there was one detection of acetone in the liquid samples and two detections in the solid samples.

Chlorinated organic compounds also were detected in samples from both tanks. Detections of chlorinated compounds such as chloromethane, chloroethane, and methylene chloride are consistent with process information, which indicates that chlorinated solvents such as carbon tetrachloride; 1,1,1-trichloroethane; and trichloroethylene were likely present in the process stream. The detection of lower-order chlorinated materials may have resulted from the degradation of process solvents. These lower-order materials must be considered as possible contaminants of concern because carbon tetrachloride; 1,1,1-trichloroethane; and trichloroethylene are constituents for which the TFF wastes have been assigned RCRA-listed hazardous waste numbers (Gilbert and Venneman 1999).

Table 3. Summary of organic compounds detected in WM-182 and WM-183 tank heels.

Tank Id#	Sample Id #	Matrix Type	Analyte	Concentration	Concentration Units	Validation Flag
182	9910262-VOA-LIQ	Water	Acetone	110	µg/L	J[a]
182	9910262-VOA-LIQ	Water	2-Butanone	10	µg/L	J
182	9910262-VOA-LIQ	Water	Ethylbenzene	4	µg/L	J
182	9910262-VOA-LIQ	Water	m-Xylene and p-Xylene	14	µg/L	J
182	9910262-VOA-LIQ-TB	Water	Benzene	5	µg/L	J
182	9910272-VOA-LIQRE	Water	Acetone	230	µg/L	E[b]J
182	9910272-VOA-LIQRE	Water	Benzene	11	µg/L	
182	9910272-VOA-LIQRE	Water	Methylene chloride	3	µg/L	J
182	9910272-VOA-LIQDL	Water	Acetone	120	µg/L:	J
182	9910272-VOA-LIQDL	Water	Chloromethane	34	µg/L	J
182	9910272-VOA-LIQDL	Water	Benzene	84	µg/L	J
182	9911014-VOA-LIQDL5	Water	Chloromethane	220	µg/L	J
182	9911014-VOA-LIQDL5	Water	Bromomethane	98	µg/L	J
182	9911014-VOA-LIQDL5	Water	Acetone	110	µg/L	J
182	9911014-VOA-LIQRE	Water	Chloromethane	530	µg/L	EJ
182	9911014-VOA-LIQRE	Water	Chloroethane	8	µg/L	J
182	9911014-VOA-LIQRE	Water	Acetone	97	µg/L	J
182	9911014-VOA-LIQRE	Water	2-Butanone	9	µg/L	J
182	WM182- SOLID COMP	Water	4-Methyl-2-pentanone	14	µg/L	R[c]
182	WM182- SOLID COMP	Water	Toluene	8	µg/L	R
182	WM182- SOLID COMP DL	Water	Chloromethane	27	µg/L	R
182	WM182- SOLID COMP DL	Water	2-Butanone	180	µg/L	R
182	WM182- SOLID COMP DL	Water	4-Methyl-2-pentanone	59	µg/L	R
182	WM182- SOLID COMP DL	Water	Toluene	22	µg/L	R
182	WM182- SOLID COMP DL	Water	2-Hexanone	140	µg/L	R
182	WM182 SOL COMP	Soil	2-Hexanone	34	µg/kg	R
183	WM183 SOLID-TOTAL	Soil	Tri-n-butylphosphate	8,600	µg/kg	R
182	9910262-SV-LIQ RE	Water	2,4-Dinitrophenol	260	µg/L	J
182	9910262-SV-LIQ RE	Water	N-Nitrosodimethylamine	31	µg/L	J
182	9910262-SV-LIQ RE	Water	Tri-n-butylphosphate	50	µg/L	J
182	9910272-SV-LIQ	Water	2,4-Dinitrophenol	66	µg/L	J
182	9910272-SV-LIQ	Water	N-Nitrosodimethylamine	16	µg/L	J
182	9911081-SV-LIQ	Water	2,4-Dinitrophenol	52	µg/L	J
183	WM183 SOL-TOT	Soil	Aroclor-1260	1,600	µg/Kg	R
183	WM183 SOL-TOT B	Soil	Aroclor-1260	1,400	µg/Kg	R
183	0001175-PCB-LIQ	Water	Aroclor-1260	2.8	µg/L	J
183	0001175-PCB-LIQB	Water	Aroclor-1260	2.5	µg/L	J
183	WM183-SOLID-TOTAL	Solid	Acetone	78	µg/Kg	J
183	WM183-SOLID-TOTAL	Solid	Methylene chloride	80	µg/Kg	J
183	WM183-011700-PROTO	Water	Chloromethane	42	µg/L	J
183	WM183-011700-PROTO	Water	Acetone	49	µg/L	
183	WM183-SOLID-TOTALDL10	Solid	Acetone	170	µg/Kg	J
183	WM183-SOLID-TOTALDL10	Solid	Methylene chloride	130	µg/Kg	J
182	9910262-SV-LIQ	Water	2,4-Dinitrophenol	260	µg/L	R

a. J = Estimated concentration.

b. E = Exceeds instrument calibration range.

c. R = Concentration is rejected quantitatively.

Detections of chlorinated organic compounds similar to methylene chloride within the tank heel materials indicate that consideration of methylene chloride as a possible contaminant of concern is appropriate. Based on process information, the semivolatile organic compound (SVOC) N-nitosodimethylamine is also consistent when considered as a possible degradation product of pyridine. In the Tank WM-182 liquid samples, there was one detection each of methylene chloride and chloroethane, two detections of N-nitosodimethylamine, and four detections of chloromethane. In the Tank WM-183 liquid samples, there were two detections of methylene chloride in the solid samples and one detection of chloromethane. Most concentrations detected were below 100 μg/L. Chloromethane was detected at concentrations greater than 100 μg/L in two samples from Tank WM-182, and methylene chloride was detected at concentrations greater than 100 μg/L in one sample from Tank WM-183.

Additional volatile organic compounds (VOCs) such as benzene, ethylbenzene, and toluene also were identified by the TFF process evaluation as likely contaminants of concern in the tank heels. Benzene, ethylbenzene, xylene, and toluene were detected in Tank WM-182 residuals. Benzene and toluene are associated with RCRA-listed hazardous waste codes for the TFF tanks (Gilbert and Venneman 1999). Therefore, they along with other aromatics must be considered as potential contaminants of concern.

In Tank WM-182 liquids, 2,4-Dinitrophenol was detected. Because of the excessive concentration of nitrate ions available in the residual liquids, the mechanism exists for the formation of 2,4-Dinitrophenol from the existing benzene, ethylbenzene, and toluene in Tank WM-182. Therefore, its presence also must be considered significant, and it should be evaluated as a potential contaminant of concern.

Aroclor-1260 was detected in Tank WM-183 solid samples and in Tank WM-183 liquid samples. The concentrations in the solid materials far exceed the concentrations in the liquid samples.

Two detections of tri-n-butylphosphate were noted: one in Tank WM-182 liquids and one in Tank WM-183 solids. This compound has been utilized historically as a chelating agent in decontamination; therefore, its presence is consistent with past practices at INTEC, and the compound must be considered a viable contaminant of concern in the tank heel system.

A single detection in Tank WM-182 liquids for bromomethane is consistent with historical data collected from the TFF. Bromomethane is most likely an intermediate product of reactions occurring during normal degradation. Bromide was not analyzed as part of the initial characterization sampling and analysis effort. However, historical data indicate the presence of bromide within the system and the presence of other organic compounds from which bromomethane could be formed.[d]

3.2.2 Summary of Positive Radionuclide Activity

Radionuclide concentrations were measured at significant levels in both WM-182 and WM-183 tank heels. Tables 4 and 5 summarize the positive radionuclide contaminants found in tank heel solids and liquids. The radionuclides detected were consistent with process knowledge. Cesium-137 and ^{90}Sr were detected at maximum concentrations near 1.0 Ci/L. The plutonium isotopes ^{238}Pu and $^{239/240}$Pu were detected at 0.5 Ci/L. Uranium also was detected at concentrations consistent with TFF process knowledge. The following radionuclides were not detected, rejected during validation, or rejected without common analytical methods: ^{242}Am, ^{243}Am, ^{242}Cm, ^{243}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{248}Cm, ^{125}Sb, ^{126}Sn, and ^{99}Tc. All these radionuclides are considered “key radionuclides” in Volume II of DOE Order 435.1 (DOE 2001a).

d. Portage Environmental, Inc., 2000, *Data Summary Report for the Characterization at the Idaho Nuclear Technology and Engineering Center WM-182 and WM-183 Tank Heels*, Draft, Portage Environmental, Inc., Idaho Falls, Idaho, January.

Table 4. Summary of radionuclides detected in solids of WM-182 and WM-183 tank heels.

Tank Id#	INEEL Sample Id#	Lab Sample Id#	Analyte	Analysis Type	Value (d/s/g)	Activity (pCi/g)	Validation Flags
182	WM182	9CN66	^{241}Am	Alpha	3.13E+04	8.46E+05	J[a]
182	WM182	9CN66	^{244}Cm	Alpha	1.05E+02	2.84E+03	
182	WM182	9CN66	^{60}Co	Gamma	3.85E+03	1.04E+05	J
182	WM182	9CN66	^{134}Cs	Gamma	2.75E+04	7.43E+05	J
182	WM182	9CN66	^{137}Cs	Gamma	1.57E+07	4.24E+08	J
182	WM182	9CN66	^{3}H	Beta	4.40E+02	1.19E+04	J
182	WM182	9CN66	^{237}Np	Alpha	6.16E+01	1.66E+03	J
182	WM182	9CN66	^{238}Pu	Alpha	7.15E+05	1.93E+07	J
182	WM182	9CN66	$^{239/240}$Pu	Alpha	5.43E+04	1.47E+06	J
182	WM182	9CN66	Total Sr	Beta	8.60E+06	2.32E+08	J
183	WM:183 SOL-TOT	0AL54	^{241}Am	Alpha	9.05E+03	2.45E+05	
183	WM:183 SOL-TOT	0AL54	^{237}Np	Alpha	6.50E+01	1.76E+03	
183	WM:183 SOL-TOT	0AL54	^{238}Pu	Alpha	1.48E+05	4.00E+06	
183	WM:183 SOL-TOT	0AL54	^{239}Pu	Alpha	4.64E+04	1.25E+06	
183	WM:183 SOL-TOT	0AL54	^{234}U	Alpha	1.25E+02	3.38E+03	
183	WM:183 SOL-TOT	0AL54	^{3}H	Beta	1.25E+03	3.38E+04	
183	WM:183 SOL-TOT	0AL54	Total Sr	Beta	6.84E+06	1.85E+08	
183	WM:183 SOL-TOT	0AL54	^{134}Cs	Gamma	2.64E+04	7.14E+05	
183	WM:183 SOL-TOT	0AL54	^{137}Cs	Gamma	3.25E+07	8.78E+08	
183	WM:183 SOL-TOT	0AL54	^{154}Eu	Gamma	2.93E+04	7.92E+05	
183	WM:183 SOL-TOT	0AL54	^{125}Sb	Gamma	1.24E+03	3.35E+04	

a. J = Estimated concentration.

Table 5. Summary of radionuclides detected in liquids of WM-182 and WM-183 tank heels.

Tank Id#	INEEL Sample Id#	Lab Sample Id#	Analyte	Analysis Type	Value (d/s/mL)	Activity (pCi/L)	Validation Flags	Mean Activity	Max Activity
182	WM182-SAM2	9CF76	^{241}Am	Alpha	1.54E+03	4.16E+07	J[a]		
182	WM182-Prot	9CF89	^{241}Am	Alpha	1.59E+03	4.30E+07	J		
182	WM182-SAM2	9CH51	^{241}Am	Alpha	1.75E+03	4.73E+07	J		
182	WM182-Prot	9CH58	^{241}Am	Alpha	1.66E+03	4.49E+07	J	4.42E+07	4.73E+07
182	WM182-SAM2	9CF76	^{244}Cm	Alpha	2.08E+01	5.62E+05			
182	WM182-Prot	9CF89	^{244}Cm	Alpha	2.64E+01	7.14E+05			
182	WM182-SAM2	9CH51	^{244}Cm	Alpha	2.18E+01	5.89E+05			
182	WM182-Prot	9CH58	^{244}Cm	Alpha	1.98E+01	5.35E+05		6.00E+05	7.14E+05
182	WM182-Prot	9CF89	^{60}Co	Gamma	5.53E+02	1.49E+07	J		
182	WM182-SAM2	9CH51	^{60}Co	Gamma	6.14E+02	1.66E+07	J		
182	WM182-Prot	9CH58	^{60}Co	Gamma	2.28E+02	6.16E+06	J	1.26E+07	1.66E+07
182	WM182-SAM2	9CF76	^{134}Cs	Gamma	8.84E+03	2.39E+08	J		
182	WM182-Prot	9CF89	^{134}Cs	Gamma	1.06E+03	2.86E+07	J		
182	WM182-SAM2	9CH51	^{134}Cs	Gamma	9.14E+03	2.47E+08	J		
182	WM182-Prot	9CH58	^{134}Cs	Gamma	9.40E+03	2.54E+08	J	1.92E+08	2.54E+08
182	WM182-SAM2	9CF76	^{137}Cs	Gamma	5.56E+06	1.50E+11	J		
182	WM182-Prot	9CF89	^{137}Cs	Gamma	5.60E+06	1.51E+11	J		
182	WM182-SAM2	9CH51	^{137}Cs	Gamma	5.49E+06	1.48E+11	J		
182	WM182-Prot	9CH58	^{137}Cs	Gamma	5.62E+06	1.52E+11	J	1.50E+11	1.52E+11
182	WM182-SAM2	9CF76	^{154}Eu	Gamma	1.52E+04	4.11E+08	J		
182	WM182-Prot	9CF89	^{154}Eu	Gamma	1.40E+03	3.78E+07	J		
182	WM182-SAM2	9CH51	^{154}Eu	Gamma	1.46E+04	3.95E+08	J		
182	WM182-Prot	9CH58	^{154}Eu	Gamma	1.43E+04	3.86E+08	J		
182	WM182	9CN66	^{154}Eu	Gamma	8.41E+03	2.27E+05	J	2.46E+08	4.11E+08
182	WM182-SAM2	9CH51	^{155}Eu	Gamma	3.93E+03	1.06E+08	J		
182	WM182-Prot	9CH58	^{155}Eu	Gamma	3.58E+03	9.68E+07	J	1.01E+08	1.06E+08
182	WM182-SAM2	9CF76	^{3}H	Beta	1.42E+03	3.84E+07	J		
182	WM182-Prot	9CF89	^{V}H	Beta	2.40E+03	6.49E+07	J		
182	WM182-SAM2	9CH51	^{3}H	Beta	2.97E+03	8.03E+07	J		
182	WM182-Prot	9CH58	^{3}H	Beta	1.84E+03	4.97E+07	J	5.83E+07	8.03E+07
182	WM182-SAM2	9CF76	^{237}Np	Alpha	1.48E+01	4.00E+05	J		
182	WM182-Prot	9CF89	^{237}Np	Alpha	1.15E+01	3.11E+05	J		
182	WM182-SAM2	9CH51	^{237}Np	Alpha	1.31E+02	3.54E+06	J		
182	WM182-Prot	9CH58	^{237}Np	Alpha	1.18E+02	3.19E+06	J	1.86E+06	3.54E+06
182	WM182-SAM2	9CF76	^{238}Pu	Alpha	1.07E+04	2.89E+08	J		
182	WM182-Prot	9CF89	^{238}Pu	Alpha	1.14E+04	3.08E+08	J		
182	WM182-SAM2	9CH51	^{238}Pu	Alpha	1.23E+04	3.32E+08	J		
182	WM182-Prot	9CH58	^{238}Pu	Alpha	1.21E+04	3.27E+08	J	3.14E+08	3.32E+08
182	WM182-SAM2	9CF76	$^{239/240}$Pu	Alpha	1.07E+03	2.89E+07	J		
182	WM182-Prot	9CF89	$^{239/240}$Pu	Alpha	1.08E+03	2.92E+07	J		

Table 5. (continued).

Tank Id#	INEEL Sample Id#	Lab Sample Id#	Analyte	Analysis Type	Value (d/s/mL)	Activity (pCi/L)	Validation Flags	Mean Activity	Max Activity
182	WM182-SAM2	9CH51	$^{239/240}$Pu	Alpha	1.26E+03	3.41E+07	J		
182	WM182-Prot	9CH58	$^{239/240}$Pu	Alpha	1.15E+03	3.11E+07	J	3.08E+07	3.41E+07
182	WM182-SAM2	9CF76	Total Sr	Beta	2.53E+06	6.84E+10	J		
182	WM182-Prot	9CF89	Total Sr	Beta	2.50E+06	6.76E+10	J		
182	WM182-SAM2	9CH51	Total Sr	Beta	2.54E+06	6.86E+10	J		
182	WM182-Prot	9CH58	Total Sr	Beta	2.69E+06	7.27E+10	J	6.93E+10	7.27E+10
182	WM182-Prot	9CF89	^{95}Zr	Gamma	1.05E+03	2.84E+07	J		
182	WM182-SAM2	9CH51	^{95}Zr	Gamma	1.21E+03	3.27E+07	J	3.05E+07	3.27E+07
182	WM182-LIQUIDRE	N/A[b]	^{63}Ni		8.43E+02	2.28E+04			
182	WM182-LIQUID	N/A	^{63}Ni		8.50E+02	2.30E+04			
182	WM182-LIQUID	N/A	^{63}Ni		7.95E+02	2.15E+04			
182	WM182-LIQUID	N/A	^{63}Ni		1.91E+03	5.16E+04		2.97E+04	5.16E+04
183	WM183-Prot	0AC04	^{241}Am	Alpha	1.61E+03	4.35E+07	J		
183	WM183-Prot	0AC34	^{241}Am	Alpha	1.49E+03	4.03E+07	J		
183	WM183-Prot	0AD66	^{241}Am	Alpha	1.42E+03	3.84E+07	J		
183	WM183-SAM1	0AD69	^{241}Am	Alpha	1.30E+03	3.51E+07	J		
183	WM183	9CP04	^{241}Am	Alpha	1.68E+03	4.54E+07	J	4.05E+07	4.54E+07
183	WM183-Prot	0AC04	^{244}Cm	Alpha	3.28E+01	8.86E+05			
183	WM183-Prot	0AC34	^{244}Cm	Alpha	2.86E+01	7.73E+05	J		
183	WM183-Prot	0AD66	^{244}Cm	Alpha	3.27E+01	8.84E+05			
183	WM183-SAM1	0AD69	^{244}Cm	Alpha	2.00E+01	5.41E+05			
183	WM183	9CP04	^{244}Cm	Alpha	2.50E+01	6.76E+05		7.52E+05	3.28E+01
183	WM183-Prot	0AC04	^{60}Co	Gamma	2.68E+03	7.24E+07	J		
183	WM183-Prot	0AC34	^{60}Co	Gamma	1.64E+03	4.43E+07	J		
183	WM183-Prot	0AD66	^{60}Co	Gamma	1.88E+03	5.08E+07	J		
183	WM183-SAM1	0AD69	^{60}Co	Gamma	1.79E+03	4.84E+07	J		
183	WM183	9CP04	^{60}Co	Gamma	1.46E+03	3.95E+07	J	5.11E+07	7.24E+07
183	WM183-Prot	0AC04	^{134}Cs	Gamma	4.80E+03	1.30E+08	J		
183	WM183-Prot	0AC34	^{134}Cs	Gamma	3.60E+03	9.73E+07	J		
183	WM183-Prot	0AD66	^{134}Cs	Gamma	4.39E+03	1.19E+08	J		
183	WM183-SAM1	0AD69	^{134}Cs	Gamma	4.17E+03	1.13E+08	J		
183	WM183	9CP04	^{134}Cs	Gamma	5.84E+03	1.58E+08	J	1.23E+08	1.58E+08
183	WM183-Prot	0AC04	^{137}Cs	Gamma	6.60E+06	1.78E+11	J		
183	WM183-Prot	0AC34	^{137}Cs	Gamma	5.33E+06	1.44E+11	J		
183	WM183-Prot	0AD66	^{137}Cs	Gamma	6.40E+06	1.73E+11	J		
183	WM183-SAM1	0AD69	^{137}Cs	Gamma	5.09E+06	1.38E+11	J		
183	WM183	9CP04	^{137}Cs	Gamma	5.26E+06	1.42E+11	J	1.55E+11	1.78E+11
183	WM183-Prot	0AC04	^{154}Eu	Gamma	2.08E+04	5.62E+08	J		
183	WM183-Prot	0AC34	^{154}Eu	Gamma	1.81E+04	4.89E+08	J		
183	WM183-Prot	0AD66	^{154}Eu	Gamma	1.91E+04	5.16E+08	J		

Table 5. (continued).

Tank Id#	INEEL Sample Id#	Lab Sample Id#	Analyte	Analysis Type	Value (d/s/mL)	Activity (pCi/L)	Validation Flags	Mean Activity	Max Activity
183	WM183-SAM1	0AD69	^{154}Eu	Gamma	1.72E+04	4.65E+08	J		
183	WM183	9CP04	^{154}Eu	Gamma	1.79E+04	4.84E+08	J	5.03E+08	5.62E+08
183	WM183-Prot	0AD66	^{155}Eu	Gamma	5.25E+03	1.42E+08	J		
183	WM183-SAM1	0AD69	^{155}Eu	Gamma	4.92E+03	1.33E+08	J		
183	WM183	9CP04	^{155}Eu	Gamma	5.41E+03	1.46E+08	J	1.40E+08	1.46E+08
183	WM183-Prot	0AC04	^{3}H	Beta	4.41E+03	1.19E+08	J		
183	WM183-Prot	0AC34	^{3}H	Beta	3.02E+03	8.16E+07	J		
183	WM183-Prot	0AD66	^{3}H	Beta	4.17E+03	1.13E+08	J		
183	WM183-SAM1	0AD69	^{3}H	Beta	3.29E+03	8.89E+07	J		
183	WM183	9CP04	^{3}H	Beta	3.59E+03	9.70E+07	J	9.99E+07	1.19E+08
183	WM183-Prot	0AC34	^{129}I	Gamma	3.61E+01	9.76E+05	J	9.76E+05	9.76E+05
183	WM183-LIQUID	N/A	^{63}Ni		1.69E+03	4.57E+07			
183	WM183-LIQUID	N/A	^{63}Ni		1.72E+03	4.65E+07			
183	WM183-LIQUID	N/A	^{63}Ni		1.43E+03	3.86E+07		4.36E+07	4.65E+07
183	WM183-Prot	0AC04	^{237}Np	Alpha	2.12E+01	5.73E+05	J		
183	WM183-Prot	0AC34	^{237}Np	Alpha	2.02E+01	5.46E+05	J		
183	WM183-Prot	0AD66	^{237}Np	Alpha	3.14E+01	8.49E+05	J		
183	WM183-SAM1	0AD69	^{237}Np	Alpha	1.86E+01	5.03E+05	J		
183	WM183	9CP04	^{237}Np	Alpha	1.52E+01	4.11E+05	J	5.76E+05	5.76E+05
183	WM183-Prot	0AC04	^{238}Pu	Alpha	2.18E+04	5.89E+08	J		
183	WM183-Prot	0AC34	^{238}Pu	Alpha	1.55E+04	4.19E+08	J		
183	WM183-Prot	0AD66	^{238}Pu	Alpha	1.17E+04	3.16E+08	J		
183	WM183-SAM1	0AD69	^{238}Pu	Alpha	1.99E+04	5.38E+08	J		
183	WM183	9CP04	^{238}Pu	Alpha	1.39E+04	3.76E+08	J	4.48E+08	5.89E+08
183	WM183-Prot	0AC04	$^{239/240}$Pu	Alpha	7.69E+03	2.08E+08	J		
183	WM183-Prot	0AC34	$^{239/240}$Pu	Alpha	4.75E+03	1.28E+08	J		
183	WM183-Prot	0AD66	$^{239/240}$Pu	Alpha	4.11E+03	1.11E+08	J		
183	WM183-SAM1	0AD69	$^{239/240}$Pu	Alpha	6.01E+03	1.62E+08	J		
183	WM183	9CP04	$^{239/240}$Pu	Alpha	2.74E+03	7.41E+07	J	1.37E+08	2.08E+08
183	WM183-Prot	0AC04	Total Sr	Beta	4.53E+06	1.22E+11	J		
183	WM183-Prot	0AC34	Total Sr	Beta	4.02E+06	1.09E+11	J		
183	WM183-Prot	0AD66	Total Sr	Beta	4.61E+06	1.25E+11	J		
183	WM183-SAM1	0AD69	Total Sr	Beta	3.98E+06	1.08E+11	J		
183	WM183	9CP04	Total Sr	Beta	3.59E+06	9.70E+10	J	1.12E+11	1.25E+11

a. J = Estimated concentration.

b. N/A = Not acceptable.

3.2.3 Summary of Inorganic/Physical Parameters

Target metals were measured in significant numbers in the WM-182 and WM-183 tank heel residuals. Table 6 summarizes the positive metals detections in tank heel solids and liquids. Table 7 summarizes detectable concentrations for anion analyses performed for the initial characterization effort.

Metals detected in Tanks WM-182 and WM-183 are consistent with process knowledge. Detections of chromium (24 mg/L), lead (6 mg/L), cadmium (5 mg/L), and mercury (17 mg/L) in Tank WM-183 solids were in concentrations that exceed Maximum Concentrations of Contaminants for the Toxicity Characteristic (TC) (40 CFR 261.24, 2001)[e]. However, the mercury TCLP concentration was rejected during data validation because it is considered questionable. In Tank WM-182 solids, only mercury (at 3 mg/L) and cadmium (at 2 mg/L) exceeded the TC standards.

Table 6. Summary of inorganic compounds detected in WM-182 and WM-183 tank heels.

Tank Id#	Sample Id#	Analyte	Matrix	Concentration	Concentration Units	Validation Flags
183	WM183-SOLID-TCLP	Barium	TCLP[a]	7.76E+02	µg/L	
183	WM183-SOLID-TCLP	Cadmium	TCLP	5.85E+03	µg/L	
183	WM183-SOLID-TCLP	Chromium	TCLP	2.46E+04	µg/L	
183	WM183-SOLID-TCLP	Lead	TCLP	6.75E+03	µg/L	
183	WM183-SOLID-TCLP	Mercury	TCLP	1.73E+04	µg/L	R[b]
183	WM183-SOLID-TCLP	Nickel	TCLP	1.70E+04	µg/L	
183	WM183-SOLID-TCLP	Silver	TCLP	6.96E+02	µg/L	
182	WM182 SOLID COMP	Barium	TCLP	2.44E+02	µg/L	
182	WM182 SOLID COMP	Cadmium	TCLP	2.19E+03	µg/L	
182	WM182 SOLID COMP	Chromium	TCLP	1.87E+03	µg/L	
182	WM182 SOLID COMP	Mercury	TCLP	3.13E+03	µg/L	J[c]
182	WM182 SOLID COMP	Nickel	TCLP	2.89E+03	µg/L	
182	WM182 SOLID COMP	Silver	TCLP	4.60E+01	µg/L	J
183	WM: 183 LIQ	Barium	Water	5.15E+03	µg/L	
183	WM: 183 LIQ	Cadmium	Water	7.29E+04	µg/L	
183	WM: 183 LIQ	Chromium	Water	2.61E+05	µg/L	J
183	WM: 183 LIQ	Lead	Water	1.22E+05	µg/L	
183	WM: 183 LIQ	Mercury	Water	3.30E+05	µg/L	J
183	WM: 183 LIQ	Nickel	Water	1.46E+05	µg/L	
183	WM: 183 LIQ	Silver	Water	2.22E+02	µg/L	J
183	WM183-SOLID-TOTAL	Aluminum	Solid	2.49E+04	mg/Kg	
183	WM183-SOLID-TOTAL	Antimony	Solid	3.20E+01	mg/Kg	J
183	WM183-SOLID-TOTAL	Arsenic	Solid	5.56E+01	mg/Kg	J
183	WM183-SOLID-TOTAL	Barium	Solid	2.36E+01	mg/Kg	
183	WM183-SOLID-TOTAL	Cadmium	Solid	1.42E+02	mg/Kg	
183	WM183-SOLID-TOTAL	Calcium	Solid	1.87E+03	mg/Kg	
183	WM183-SOLID-TOTAL	Chromium	Solid	9.49E+02	mg/Kg	
183	WM183-SOLID-TOTAL	Cobalt	Solid	9.30E+00	mg/Kg	
183	WM183-SOLID-TOTAL	Copper	Solid	1.66E+02	mg/Kg	
183	WM183-SOLID-TOTAL	Iron	Solid	1.80E+04	mg/Kg	

e. The RCRA TC regulatory concentration levels are 5.0 mg/L for chromium, 5.0 mg/L for lead, 1.0 mg/L for cadmium, and 0.2 mg/L for mercury.

Table 6. (continued).

Tank Id#	Sample Id#	Analyte	Matrix	Concentration	Concentration Units	Validation Flags
183	WM183-SOLID-TOTAL	Lead	Solid	2.74E+02	mg/Kg	
183	WM183-SOLID-TOTAL	Magnesium	Solid	4.34E+02	mg/Kg	
183	WM183-SOLID-TOTAL	Manganese	Solid	7.40E+02	mg/Kg	
183	WM183-SOLID-TOTAL	Mercury	Solid	3.24E+02	mg/Kg	
183	WM183-SOLID-TOTAL	Nickel	Solid	4.17E+02	mg/Kg	
183	WM183-SOLID-TOTAL	Silver	Solid	2.20E+02	mg/Kg	
183	WM183-SOLID-TOTAL	Vanadium	Solid	1.07E+01	mg/Kg	
183	WM183-SOLID-TOTAL	Zinc	Solid	1.48E+02	mg/Kg	
182	WM182 SOLID COMP TOTALS	Aluminum	Solid	2.19E+04	mg/Kg	J
182	WM182 SOLID COMP TOTALS	Arsenic	Solid	2.81E+02	mg/Kg	J
182	WM182 SOLID COMP TOTALS	Barium	Solid	1.27E+02	mg/Kg	
182	WM182 SOLID COMP TOTALS	Cadmium	Solid	3.25E+02	mg/Kg	J
182	WM182 SOLID COMP TOTALS	Calcium	Solid	1.76E+03	mg/Kg	J
182	WM182 SOLID COMP TOTALS	Chromium	Solid	5.52E+02	mg/Kg	
182	WM182 SOLID COMP TOTALS	Iron	Solid	4.48E+03	mg/Kg	
182	WM182 SOLID COMP TOTALS	Lead	Solid	3.69E+02	mg/Kg	
182	WM182 SOLID COMP TOTALS	Magnesium	Solid	4.10E+02	mg/Kg	
182	WM182 SOLID COMP TOTALS	Manganese	Solid	5.65E+02	mg/Kg	
182	WM182 SOLID COMP TOTALS	Mercury	Solid	3.10E+02	mg/Kg	
182	WM182 SOLID COMP TOTALS	Nickel	Solid	3.09E+02	mg/Kg	
182	WM182 SOLID COMP TOTALS	Selenium	Solid	9.11E+01	mg/Kg	J
182	WM182 SOLID COMP TOTALS	Silver	Solid	6.47E+01	mg/Kg	J
182	WM182 SOLID COMP TOTALS	Vanadium	Solid	1.33E+01	mg/Kg	
182	WM182 SOLID COMP TOTALS	Zinc	Solid	1.79E+02	mg/Kg	
182	WM182-SOLID-COMPR	Mercury	TCLP	3.16E+03	µg/L	J
182	9910262 LIQUID	Aluminum	Water	8.05E+06	µg/L	
182	9910262 LIQUID	Barium	Water	3.49E+03	µg/L	
182	9910262 LIQUID	Beryllium	Water	3.03E+01	µg/L	
182	9910262 LIQUID	Cadmium	Water	6.09E+04	µg/L	
182	9910262 LIQUID	Calcium	Water	5.24E+05	µg/L	
182	9910262 LIQUID	Chromium	Water	1.01E+05	µg/L	
182	9910262 LIQUID	Cobalt	Water	8.68E+02	µg/L	
182	9910262 LIQUID	Copper	Water	1.29E+04	µg/L	J
182	9910262 LIQUID	Iron	Water	6.25E+05	µg/L	
182	9910262 LIQUID	Lead	Water	7.28E+04	µg/L	
182	9910262 LIQUID	Magnesium	Water	1.01E+05	µg/L	
182	9910262 LIQUID	Manganese	Water	2.39E+05	µg/L	
182	9910262 LIQUID	Mercury	Water	1.78E+05	µg/L	
182	9910262 LIQUID	Nickel	Water	5.05E+04	µg/L	
182	9910262 LIQUID	Vanadium	Water	4.84E+02	µg/L	
182	9910262 LIQUID	Zinc	Water	2.32E+04	µg/L	
182	9910272 LIQUID	Aluminum	Water	7.68E+06	µg/L	
182	9910272 LIQUID	Barium	Water	3.33E+03	µg/L	
182	9910272 LIQUID	Beryllium	Water	3.03E+01	µg/L	
182	9910272 LIQUID	Cadmium	Water	5.97E+04	µg/L	
182	9910272 LIQUID	Calcium	Water	5.02E+05	µg/L	

Table 6. (continued).

Tank Id#	Sample Id#	Analyte	Matrix	Concentration	Concentration Units	Validation Flags
182	9910272 LIQUID	Chromium	Water	9.66E+04	µg/L	
182	9910272 LIQUID	Cobalt	Water	8.78E+02	µg/L	
182	9910272 LIQUID	Copper	Water	1.68E+04	µg/L	J
182	9910272 LIQUID	Iron	Water	5.95E+05	µg/L	
182	9910272 LIQUID	Lead	Water	7.07E+04	µg/L	
182	9910272 LIQUID	Magnesium	Water	9.59E+04	µg/L	
182	9910272 LIQUID	Manganese	Water	2.28E+05	µg/L	
182	9910272 LIQUID	Mercury	Water	1.59E+05	µg/L	
182	9910272 LIQUID	Nickel	Water	5.00E+04	µg/L	
182	9910272 LIQUID	Vanadium	Water	5.25E+02	µg/L	
182	9910272 LIQUID	Zinc	Water	3.60E+04	µg/L	
182	9911081 LIQUID	Aluminum	Water	7.52E+06	µg/L	
182	9911081 LIQUID	Barium	Water	3.47E+03	µg/L	
182	9911081 LIQUID	Beryllium	Water	3.03E+01	µg/L	
182	9911081 LIQUID	Cadmium	Water	6.02E+04	µg/L	
182	9911081 LIQUID	Calcium	Water	5.02E+05	µg/L	
182	9911081 LIQUID	Chromium	Water	9.82E+04	µg/L	
182	9911081 LIQUID	Cobalt	Water	8.37E+02	µg/L	
182	9911081 LIQUID	Copper	Water	1.33E+04	µg/L	J
182	9911081 LIQUID	Iron	Water	6.32E+05	µg/L	
182	9911081 LIQUID	Lead	Water	7.32E+04	µg/L	
182	9911081 LIQUID	Magnesium	Water	9.44E+04	µg/L	
182	9911081 LIQUID	Manganese	Water	2.23E+05	µg/L	
182	9911081 LIQUID	Mercury	Water	1.72E+05	µg/L	
182	9911081 LIQUID	Nickel	Water	4.88E+04	µg/L	
182	9911081 LIQUID	Vanadium	Water	4.94E+02	µg/L	
182	9911081 LIQUID	Zinc	Water	2.58E+04	µg/L	
182	9911082 LIQUID	Aluminum	Water	8.03E+06	µg/L	
182	9911082 LIQUID	Barium	Water	3.52E+03	µg/L	
182	9911082 LIQUID	Beryllium	Water	3.03E+01	µg/L	
182	9911082 LIQUID	Cadmium	Water	6.08E+04	µg/L	
182	9911082 LIQUID	Calcium	Water	5.13E+05	µg/L	
182	9911082 LIQUID	Chromium	Water	1.00E+05	µg/L	
182	9911082 LIQUID	Cobalt	Water	8.78E+02	µg/L	
182	9911082 LIQUID	Copper	Water	1.24E+04	µg/L	J
182	9911082 LIQUID	Iron	Water	6.48E+05	µg/L	
182	9911082 LIQUID	Lead	Water	7.40E+04	µg/L	
182	9911082 LIQUID	Magnesium	Water	9.39E+04	µg/L	
182	9911082 LIQUID	Manganese	Water	2.29E+05	µg/L	
182	9911082 LIQUID	Nickel	Water	5.09E+04	µg/L	
182	9911082 LIQUID	Silver	Water	2.32E+02	µg/L	
182	9911082 LIQUID	Vanadium	Water	4.54E+02	µg/L	
182	9911082 LIQUID	Zinc	Water	2.25E+04	µg/L	
183	0001125-LIQUID	Aluminum	Water	1.19E+07	µg/L	
183	0001125-LIQUID	Antimony	Water	4.70E+02	µg/L	
183	0001125-LIQUID	Arsenic	Water	7.90E+02	µg/L	

Table 6. (continued).

Tank Id#	Sample Id#	Analyte	Matrix	Concentration	Concentration Units	Validation Flags
183	0001125-LIQUID	Barium	Water	6.92E+03	µg/L	
183	0001125-LIQUID	Beryllium	Water	6.00E+01	µg/L	
183	0001125-LIQUID	Cadmium	Water	8.31E+04	µg/L	
183	0001125-LIQUID	Calcium	Water	1.09E+06	µg/L	
183	0001125-LIQUID	Chromium	Water	4.48E+05	µg/L	
183	0001125-LIQUID	Cobalt	Water	5.35E+03	µg/L	
183	0001125-LIQUID	Copper	Water	1.10E+05	µg/L	
183	0001125-LIQUID	Iron	Water	1.95E+06	µg/L	
183	0001125-LIQUID	Lead	Water	1.58E+05	µg/L	
183	0001125-LIQUID	Magnesium	Water	2.08E+05	µg/L	
183	0001125-LIQUID	Manganese	Water	4.67E+05	µg/L	
183	0001125-LIQUID	Mercury	Water	4.40E+05	µg/L	
183	0001125-LIQUID	Nickel	Water	2.33E+05	µg/L	
183	0001125-LIQUID	Silver	Water	6.10E+02	µg/L	
183	0001125-LIQUID	Thallium	Water	1.16E+03	µg/L	
183	0001125-LIQUID	Vanadium	Water	1.76E+03	µg/L	
183	0001125-LIQUID	Zinc	Water	9.52E+04	µg/L	
183	0001175-LIQUID	Aluminum	Water	1.06E+07	µg/L	
183	0001175-LIQUID	Antimony	Water	6.70E+02	µg/L	
183	0001175-LIQUID	Barium	Water	6.53E+03	µg/L	
183	0001175-LIQUID	Beryllium	Water	5.00E+01	µg/L	
183	0001175-LIQUID	Cadmium	Water	7.50E+04	µg/L	
183	0001175-LIQUID	Calcium	Water	9.46E+05	µg/L	
183	0001175-LIQUID	Chromium	Water	3.88E+05	µg/L	
183	0001175-LIQUID	Cobalt	Water	4.75E+03	µg/L	
183	0001175-LIQUID	Copper	Water	7.86E+04	µg/L	
183	0001175-LIQUID	Iron	Water	1.68E+06	µg/L	
183	0001175-LIQUID	Lead	Water	1.35E+05	µg/L	
183	0001175-LIQUID	Magnesium	Water	1.81E+05	µg/L	
183	0001175-LIQUID	Manganese	Water	3.96E+05	µg/L	
183	0001175-LIQUID	Mercury	Water	2.68E+05	µg/L	
183	0001175-LIQUID	Nickel	Water	1.90E+05	µg/L	
183	0001175-LIQUID	Silver	Water	3.60E+02	µg/L	
183	0001175-LIQUID	Thallium	Water	3.90E+02	µg/L	
183	0001175-LIQUID	Vanadium	Water	1.53E+03	µg/L	
183	0001175-LIQUID	Zinc	Water	7.59E+04	µg/L	
183	0001191-LIQUID	Aluminum	Water	1.44E+07	µg/L	
183	0001191-LIQUID	Antimony	Water	3.40E+02	µg/L	
183	0001191-LIQUID	Arsenic	Water	4.80E+02	µg/L	
183	0001191-LIQUID	Barium	Water	8.39E+03	µg/L	
183	0001191-LIQUID	Beryllium	Water	7.00E+01	µg/L	
183	0001191-LIQUID	Cadmium	Water	9.29E+04	µg/L	
183	0001191-LIQUID	Calcium	Water	1.29E+06	µg/L	
183	0001191-LIQUID	Chromium	Water	5.99E+05	µg/L	
183	0001191-LIQUID	Cobalt	Water	6.49E+03	µg/L	
183	0001191-LIQUID	Copper	Water	6.82E+04	µg/L	

Table 6. (continued).

Tank Id#	Sample Id#	Analyte	Matrix	Concentration	Concentration Units	Validation Flags
183	0001191-LIQUID	Iron	Water	2.48E+06	µg/L	
183	0001191-LIQUID	Lead	Water	1.80E+05	µg/L	
183	0001191-LIQUID	Magnesium	Water	2.33E+05	µg/L	
183	0001191-LIQUID	Manganese	Water	5.72E+05	µg/L	
183	0001191-LIQUID	Mercury	Water	3.78E+05	µg/L	
183	0001191-LIQUID	Nickel	Water	2.66E+05	µg/L	
183	0001191-LIQUID	Silver	Water	8.10E+02	µg/L	
183	0001191-LIQUID	Thallium	Water	1.11E+03	µg/L	
183	0001191-LIQUID	Vanadium	Water	2.04E+03	µg/L	
183	0001191-LIQUID	Zinc	Water	7.04E+04	µg/L	
183	0001192-LIQUID	Aluminum	Water	9.47E+06	µg/L	
183	0001192-LIQUID	Antimony	Water	4.70E+02	µg/L	
183	0001192-LIQUID	Arsenic	Water	4.70E+02	µg/L	
183	0001192-LIQUID	Barium	Water	5.85E+03	µg/L	
183	0001192-LIQUID	Beryllium	Water	5.00E+01	µg/L	
183	0001192-LIQUID	Cadmium	Water	7.00E+04	µg/L	
183	0001192-LIQUID	Calcium	Water	8.36E+05	µg/L	
183	0001192-LIQUID	Chromium	Water	3.33E+05	µg/L	
183	0001192-LIQUID	Cobalt	Water	4.38E+03	µg/L	
183	0001192-LIQUID	Copper	Water	3.80E+04	µg/L	
183	0001192-LIQUID	Iron	Water	1.52E+06	µg/L	
183	0001192-LIQUID	Lead	Water	1.17E+05	µg/L	
183	0001192-LIQUID	Magnesium	Water	1.60E+05	µg/L	
183	0001192-LIQUID	Manganese	Water	3.65E+05	µg/L	
183	0001192-LIQUID	Mercury	Water	3.04E+05	µg/L	
183	0001192-LIQUID	Nickel	Water	1.83E+05	µg/L	
183	0001192-LIQUID	Selenium	Water	2.80E+02	µg/L	
183	0001192-LIQUID	Silver	Water	4.20E+02	µg/L	
183	0001192-LIQUID	Thallium	Water	7.60E+02	µg/L	
183	0001192-LIQUID	Vanadium	Water	1.34E+03	µg/L	
183	0001192-LIQUID	Zinc	Water	4.64E+04	µg/L	

a. TCLP = Toxicity characteristic leaching procedure.

b. R = Concentration is rejected quantitatively.

c. J = Estimated concentration.

Table 7. Summary of anions detected in WM-182 and WM-183 tank heels.

Tank Id#	Sample Id#	Analyte	Matrix	Concentration	Concentration Units	Validation Flags
183	0001125-LIQUID	Chloride	Water	3.11E+02	mg/L	
183	0001125-LIQUID	Fluoride	Water	8.27E+02	mg/L	
183	0001125-LIQUID	Nitrate	Water	1.09E+05	mg/L	
183	0001125-LIQUID	Sulfate	Water	1.44E+03	mg/L	
183	0001175-LIQUID	Chloride	Water	2.93E+02	mg/L	
183	0001175-LIQUID	Fluoride	Water	7.32E+02	mg/L	
183	0001175-LIQUID	Nitrate	Water	1.91E+05	mg/L	
183	0001175-LIQUID	Sulfate	Water	2.36E+03	mg/L	
183	0001191-LIQUID	Chloride	Water	3.08E+02	mg/L	
183	0001191-LIQUID	Fluoride	Water	6.62E+02	mg/L	
183	0001191-LIQUID	Nitrate	Water	2.01E+05	mg/L	
183	0001191-LIQUID	Sulfate	Water	2.58E+03	mg/L	
183	0001192-LIQUID	Chloride	Water	2.52E+02	mg/L	
183	0001192-LIQUID	Fluoride	Water	6.03E+02	mg/L	
183	0001192-LIQUID	Nitrate	Water	1.83E+05	mg/L	
183	0001192-LIQUID	Sulfate	Water	2.25E+03	mg/L	
183	WM183-SOLID-TOTAL	Chloride	Solid	1.31E+03	mg/Kg	
183	WM183-SOLID-TOTAL	Fluoride	Solid	4.37E+03	mg/Kg	
183	WM183-SOLID-TOTAL	Nitrate	Solid	1.75E+05	mg/Kg	
183	WM183-SOLID-TOTAL	Phosphate	Solid	1.26E+05	mg/Kg	
183	WM183-SOLID-TOTAL	Sulfate	Solid	1.36E+04	mg/Kg	
182	WM182 SOLID COMP	Chloride	Water Extract	2.02E+03	mg/Kg	J[a]
182	WM182 SOLID COMP	Fluoride	Water Extract	1.49E+04	mg/Kg	J
182	WM182 SOLID COMP	Nitrate	Water Extract	7.07E+04	mg/Kg	R[b]
182	WM182 SOLID COMP	Phosphate	Water Extract	6.84E+04	mg/Kg	J
182	WM182 SOLID COMP	Sulfate	Water Extract	3.32E+04	mg/Kg	J

a. J = Estimated concentration.

b. R = Concentration is rejected quantitatively.

Concentrations of metals in liquid are generally greater in Tank WM-183. The metals concentrations in the liquid phase and the possible inability to remove all liquids may account for the higher TCLP values and the more frequent detections at greater than TC limits. Concentrations of metals in solids were generally two to three orders of magnitude greater than the concentrations in liquids. A comparison of metals concentrations in the liquids with TC limits is provided in Section 3.3.1.4.

The detectable anions in the WM-182 and WM-183 tank heels are chloride, fluoride, nitrate, sulfate, and phosphate. Five samples were taken from Tank WM-183 and one sample was taken from Tank WM-182. In the WM-183 tank heel, phosphate was detected in the solid sample.

3.3 Statistical Analyses of Initial Characterization Data

Statistical analyses were performed on the data to investigate the properties of the contents of Tanks WM-182 and WM-183. The primary goal of the analysis was to determine the sample size required to meet the DQO requirements for each analyte. The secondary goal was to examine how the concentrations of the tested constituents varied between tanks. Ratios were also calculated to analyze the

difference in concentrations of analytes between the solid matrix and the liquid matrix for the metals and radionuclides in each tank. This section provides information on the type of statistical analyses that were performed and summarizes the results of the analyses.

3.3.1 Tank Comparison

This section provides justification for the statistical methods that were applied to the data to compare the contents of the two tanks. Data were analyzed separately for each tank. In some instances, data were analyzed for both tanks combined. However, data from the liquid matrix were always analyzed separately from the data for the solid matrix.

3.3.1.1 Histograms. A histogram is a graphic representation of frequency distribution in which the data from various intervals or bins are separated and the frequency of the data in each bin is plotted. A histogram displays the overall distribution, or shape, of the data and can show many trends and irregularities, such as data outliers. Creation of a histogram is one of the first steps in determining whether or not the data follow a normal distribution.

Histograms were constructed for each of the metals, anions, and radionuclides that were analyzed; were detected; and had two or more observations in a given tank. Histograms were not generated from measurements taken from the solid matrix as there was no more than one measurement per tank for any analyte. If sufficient data were available for both tanks for a particular analyte, three histograms were made for that analyte. Two histograms were made, one for each tank, as well as a third histogram for the combined data from both tanks. If sufficient data were only available from one tank, only one histogram was made for that analyte.

The histograms consistently show a trend for the metal analyses between the tank heels. The data for Tank WM-182 had a different range and spread than the data for Tank WM-183; in every case, the data for Tank WM-182 show lower concentrations and a smaller range of values than the data for Tank WM-183. Examination of the histograms showed that none of the analyte concentrations appeared to follow a normal distribution for either tank or for the combined data.

Histograms of anion data for Tank WM-182 could not be created, because only one measurement per analyte was available for that tank. However, there were enough anion data to construct histograms for Tank WM-183. The histograms for Tank WM-183 showed that none of the anion data exhibited a normal distribution.

Histograms also were generated for the detectable radionuclides in the liquid matrix for Tanks WM-182 and WM-183 heels and for the combined data from both tanks. No particular trend was noticeable from the histograms. The histograms show no evidence that the radionuclides in either tank or for the combined data exhibit a normal distribution.

A complete set of histograms is not included in this SAP as the histograms provide no more information than the summary statistics listed in the tables that follow in this subsection; however, one histogram is included, Figure 2, as an example.

3.3.1.2 Normal Probability Plots. A normal probability plot was used to assess the degree of normality of the data. The normal probability plot is a graph of the quantiles of a data set against the quantiles of the normal distribution. If the points on the graph follow a straight line, then the data are considered to follow the normal distribution. If the data varies from a straight line, then the data are considered non-normal in distribution.

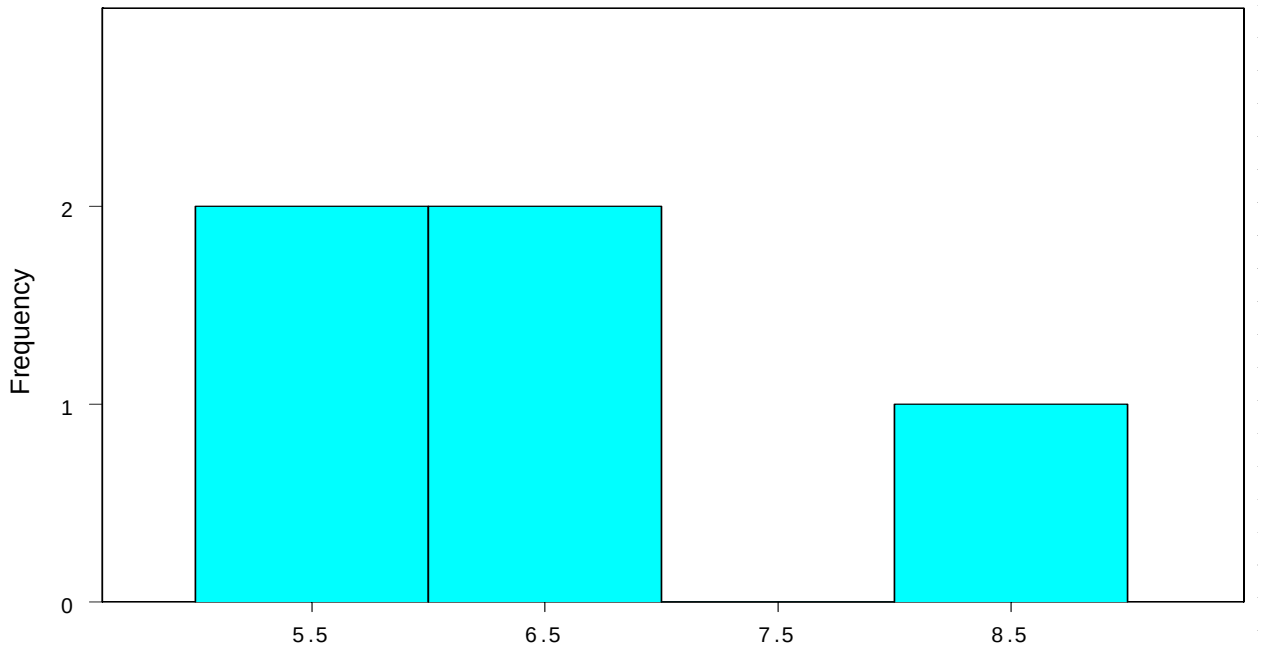


Figure 2. Histogram for barium data collected from WM-183 tank heel.

Normal probability plots were made for each data set for which a histogram had previously been constructed. None of the metals, anions, or radionuclides demonstrated a normal distribution for either tank or for the combined data from both tanks. Therefore, a complete set of normal probability plots is not included in this SAP; however, one of the plots is included, Figure 3, as an example.

3.3.1.3 Summary Statistics. One of the primary goals of this statistical evaluation is the comparison of Tank WM-182 and Tank WM-183 heels against each other with respect to analyte concentration. To examine the differences and similarities between the tanks more closely, each tank was compared by analyte and by matrix (liquid or solid). This was done by calculating summary statistics for each analyte by tank. If there were two or more observations measured and detected for a particular analyte in a tank, the mean, median, standard deviation, range, minimum concentration, and maximum concentration were calculated. If only one measurement was recorded, then this was the value used for comparison.

The metals in the tank heel liquid matrix demonstrated a trend that the average concentration in Tank WM-182 was consistently less than the average concentration in Tank WM-183. The difference was so extreme for each of the metals, with the exception of silver, that the maximum measured concentration in Tank WM-182 was less than the minimum measured concentration in Tank WM-183. The maximum measured concentration for silver in Tank WM-182 was 0.232 mg/L and the minimum measured concentration in Tank WM-183 was 0.222 mg/L. By examining the full set of summary statistics for silver, on average the concentration of silver is greater in Tank WM-183 than in Tank WM-182. Hypothesis tests were not performed on the difference between the means because the data did not exhibit sufficient normality to perform the tests. A trend was also seen in the spread of the data between the two tanks. The standard deviation and the range both demonstrate that there is much larger variation in the concentration measurements in Tank WM-183 than in Tank WM-182. The range and standard deviation were larger in Tank WM-183 than in Tank WM-182 for every metal measured. The summary statistics for metals in the liquid matrix can be found in Table 8.

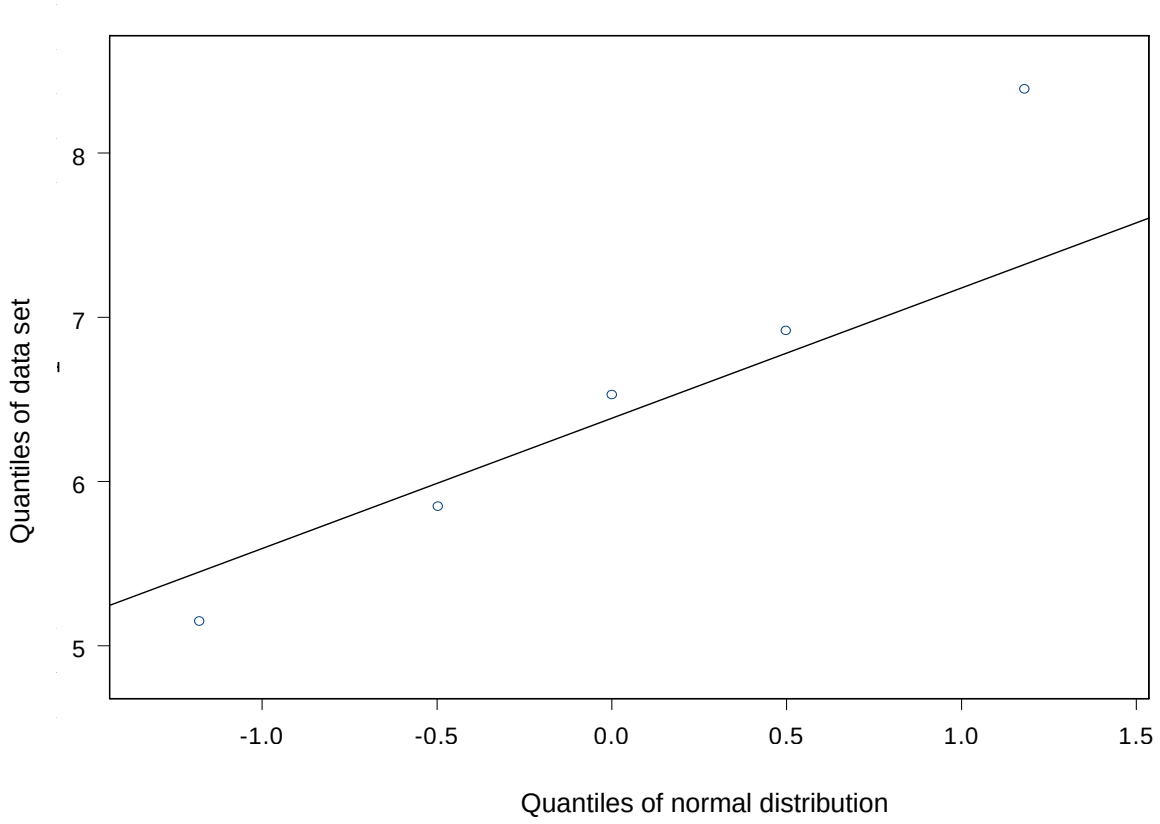


Figure 3. Normal probability plot for barium data collected from WM-183 tank heel.

Table 8. Summary statistics for liquids in Tanks WM-182 and WM-183 heels.

Metal	Statistic	Tank WM-182 (mg/L)	Tank WM-183 (mg/L)
Aluminum	Mean	7,820	11,592.5
	Standard Deviation	131.21	1,059.35
	Median	7,855	11,250
	Range	530	4,930
	Minimum	7,520	9,470
	Maximum	8,050	14,400
Antimony	Mean	Undetected	0.49
	Standard Deviation	Undetected	0.07
	Median	Undetected	0.47
	Range	Undetected	0.33
	Minimum	Undetected	0.34
	Maximum	Undetected	0.67
Arsenic	Mean	Undetected	0.39
	Standard Deviation	Undetected	0.13
	Median	Undetected	0.47
	Range	Undetected	0.68
	Minimum	Undetected	0.11
	Maximum	Undetected	0.79

Table 8. (continued).

Metal	Statistic	Tank WM-182 (mg/L)	Tank WM-183 (mg/L)
Barium	Mean	3.45	6.57
	Standard Deviation	0.04	0.55
	Median	3.48	6.53
	Range	0.19	3.24
	Minimum	3.33	5.15
	Maximum	3.52	8.39
Beryllium	Mean	0.0303	0.0575
	Standard Deviation	0	0.0048
	Median	0.0303	0.055
	Range	0.0303	0.02
	Minimum	0	0.05
	Maximum	0.0303	0.07
Cadmium	Mean	60.4	78.78
	Standard Deviation	0.28	4.15
	Median	60.5	75
	Range	1.2	22.9
	Minimum	59.7	70
	Maximum	60.9	92.9
Calcium	Mean	510.25	1,040.5
	Standard Deviation	5.27	98.09
	Median	507.5	1,018
	Range	22	454
	Minimum	502	836
	Maximum	524	1,290
Chromium	Mean	98.95	405.8
	Standard Deviation	0.97	57.31
	Median	99.1	388
	Range	4.4	338
	Minimum	96.6	261
	Maximum	101	599
Cobalt	Mean	0.865	5.243
	Standard Deviation	0.010	0.461
	Median	0.873	5.050
	Range	0.041	2.110
	Minimum	0.837	4.380
	Maximum	0.878	6.490
Copper	Mean	13.85	73.7
	Standard Deviation	1.00	14.85
	Median	13.1	73.4
	Range	4.4	72
	Minimum	12.4	38
	Maximum	16.8	110

Table 8. (continued).

Metal	Statistic	Tank WM-182 (mg/L)	Tank WM-183 (mg/L)
Iron	Mean	625	1,907.5
	Standard Deviation	11.10	210.45
	Median	628.5	1,815
	Range	53	960
	Minimum	595	1,520
	Maximum	648	2,480
Lead	Mean	72.675	142.4
	Standard Deviation	0.704	11.775
	Median	73	135
	Range	3.3	63
	Minimum	70.7	117
	Maximum	74	180
Magnesium	Mean	96.3	195.5
	Standard Deviation	1.62	15.90
	Median	95.15	194.5
	Range	7.1	73
	Minimum	93.9	160
	Maximum	101	233
Manganese	Mean	229.75	450
	Standard Deviation	3.35	45.93
	Median	228.5	431.5
	Range	16	207
	Minimum	223	365
	Maximum	239	572
Mercury	Mean	169.67	344
	Standard Deviation	5.61	29.95
	Median	172	330
	Range	19	172
	Minimum	159	268
	Maximum	178	440
Nickel	Mean	50.05	203.6
	Standard Deviation	0.46	20.84
	Median	50.25	190
	Range	2.1	120
	Minimum	48.8	146
	Maximum	50.9	266
Selenium	Mean	Undetected	0.28
	Standard Deviation	Undetected	0
	Median	Undetected	.028
	Range	Undetected	.028
	Minimum	Undetected	.028
	Maximum	Undetected	.028

Table 8. (continued).

Metal	Statistic	Tank WM-182 (mg/L)	Tank WM-183 (mg/L)
Silver	Mean	0.126	0.484
	Standard Deviation	0.035	0.103
	Median	0.091	0.42
	Range	0.141	0.588
	Minimum	0.091	0.222
	Maximum	0.232	0.81
Thallium	Mean	Undetected	0.855
	Standard Deviation	Undetected	0.179
	Median	Undetected	0.935
	Range	Undetected	0.77
	Minimum	Undetected	0.39
	Maximum	Undetected	1.16
Vanadium	Mean	0.489	1.668
	Standard Deviation	0.015	0.151
	Median	0.489	1.645
	Range	0.071	0.700
	Minimum	0.454	1.340
	Maximum	0.525	2.040
Zinc	Mean	26.875	71.975
	Standard Deviation	3.123	10.047
	Median	24.5	73.15
	Range	13.5	48.8
	Minimum	22.5	46.4
	Maximum	36	95.2

The metals in the tank heel solid matrix did not exhibit any trend. As only one measurement per tank was taken in the solid matrix, there is no way to analyze the difference in variation in the concentrations of the metals between tanks. However, higher concentrations of arsenic, barium, cadmium, lead, selenium, vanadium, and zinc were found in Tank WM-182. Higher concentrations of aluminum, antimony, calcium, chromium, cobalt, iron, magnesium, manganese, mercury, nickel, silver, and thallium were measured in Tank WM-183. Beryllium was not detected in either measurement, and the copper measurement in Tank WM-182 was rejected so no comparisons can be made for either analyte. The summary statistics for the metals in the solid matrix can be found in Tables 9 and 10.

A comparison of anions measured in the liquid matrix for each tank could only be performed on chloride, fluoride, nitrate, and sulfate as these were the only anions detected in both tanks. One measurement was taken in Tank WM-182 and four measurements were taken in Tank WM-183 for each of these analytes. There appears to be a much higher concentration of nitrate in Tank WM-183 than in Tank WM-182 and notably higher concentrations of chloride and sulfate in Tank WM-183 as opposed to Tank WM-182. The mean concentration of fluoride in Tank WM-182 was slightly higher than the mean concentration in Tank WM-183. There was no comparison of anions for b-acid phosphate because of a lack of data. There was also no analysis performed on anion concentrations in the solid matrix because no measurements were taken in Tank WM-182 and only one measurement was taken in Tank WM-183. The summary statistics for anion analyses in the liquids can be found in Table 11.

Table 9. Comparison of TCLP metals concentrations in solid matrix of WM-182 and WM-183 tank heels.

Analyte	Tank WM-182 (mg/L)	Exceeding Regulatory Level	Tank WM-183 (mg/L)	Exceeding Regulatory Level	TCLP Regulatory Levels (mg/L)
Arsenic	ND[a]	No	ND	No	5.0
Barium	0.24	No	0.78	No	100.0
Cadmium	2.2	Yes	5.8	Yes	1.0
Chromium	1.9	No	24	Yes	5.0
Lead	ND	No	6.7	Yes	5.0
Mercury	3.1	Yes	17 R[b]	Yes	0.2
Selenium	NP[c]	No	ND	No	1.0
Silver	0.046	No	0.70	No	5.0

a. ND = Not detected.

b. R = Rejected during data validation.

c. NP = Not performed.

Table 10. Comparison of metals concentrations in the solid matrix of WM-182 and WM-183 tank heels.

Analyte	Tank WM-182 (mg/kg)	Tank WM-183 (mg/kg)
Aluminum	21,900	24,900
Antimony	ND[a]	32
Beryllium	ND	ND
Calcium	1,760	1,870
Cobalt	ND	9.3
Copper	ND	166
Iron	4,480	18,000
Magnesium	410	434
Manganese	565	740
Thallium	ND	ND
Vanadium	13.3	10.7
Zinc	179	148

a. ND = Not detected.

Table 11. Summary statistics for anions in liquids of WM-182 and WM-183 tank heels.

Anion	Tank WM-182 (mg/L)	Tank WM-183 Minimum (mg/L)	TankWM-183 Mean (mg/L)
Chloride	101	252	291
Fluoride	745	603	706
Nitrate	3,535	10,900	171,000
Sulfate	1,660	1,440	2,157.2

The radionuclide data from the liquid matrix show a trend. The mean concentration from Tank WM-182 was less than the mean concentration from Tank WM-183 for every detectable radionuclide except for ^{241}Am and ^{237}Np. No trend was seen in the variation of the concentration measurements between the two tanks. The radionuclides in the solid matrix show no such trend. The mean concentrations of ^{241}Am, ^{244}Cm, ^{60}Co, ^{238}Pu, and $^{239/240}$Pu are higher in Tank WM-182 than in Tank WM-183. The radionuclide variance could not be analyzed, because only one measurement per analyte was taken in each tank. The summary statistics for the radionuclides can be found in Tables 12 and 13.

3.3.1.4 Detection Levels. This section summarizes the measured concentration of the constituents of interest before Tanks WM-182 and WM-183 were decontaminated and describes how those measurements relate to the TCLP action levels of each constituent. (Where pertinent, the TCLP maximum concentration limits are shown in parentheses after the analyte.) The analytes that were not detected in a particular tank or whose measured concentration was far below the TCLP action level are of no particular interest. Only the metals are discussed in this section, because the anions exhibited high concentrations in both tanks. The results for this subsection are based on the information in Tables 6, 8, 9 and 10. This information is based on four measurements per analyte per tank, at most, and sometimes as little as one measurement per analyte per tank. Where direct TCLP measurements on samples of tank heel solids were not available, total constituent analysis data were compared to the TCLP regulatory limits by dividing the total analysis result (mg/kg) by 20 to obtain the maximum possible TCLP results in mg/L.

The summary statistics in Table 8 show that if an analyte had a low concentration in one of the tank heels, then that same analyte had a low concentration in the other tank heel. However, an analyte may have been detected in one tank heel but not in the other. Selenium was detected only once in each tank heel; therefore, no further statistical analysis was needed. The trend described was evident in both the liquid and solid matrices.

In Tank WM-182, the following analytes were not detected in the liquid matrix: antimony, arsenic, selenium, and thallium. Analytes measured at concentrations of less than 1.0 mg/L were beryllium, cobalt, silver, and vanadium. All detections of barium were below the TCLP maximum concentration limit of 100 mg/L.

In Tank WM-182 solids, none of the following were detected: antimony, beryllium, cobalt, and thallium. Vanadium was measured at a concentration of less than 1.0 mg/L. Selenium was detected in a total constituent analysis at 91.1 mg/kg. This concentration would result in a TCLP concentration below the TCLP maximum concentration limit of 1.0 mg/L, even if all the selenium detected were to leach into a TCLP sample.

Table 12. Summary statistics for radionuclides in liquids of WM-182 and WM-183 tank heels.

Radionuclide	Statistic	Tank WM-182 (pCi/L)	Tank WM-183 (pCi/L)
^{241}Am	Mean	4.42E+07	4.05E+07
	Standard Deviation	1.23E+06	1.82E+06
	Median	4.39E+07	4.03E+07
	Range	5.68E+06	1.03E+07
	Minimum	4.16E+07	3.51E+07
	Maximum	4.73E+07	4.54E+07
^{244}Cm	Mean	6.00E+05	7.52E+05
	Standard Deviation	3.94E+04	6.57E+04
	Median	5.76E+05	7.73E+05
	Range	1.78E+05	3.46E+05
	Minimum	5.35E+05	5.41E+05
	Maximum	7.14E+05	8.86E+05
^{60}Co	Mean	1.26E+07	5.11E+07
	Standard Deviation	3.24E+06	5.67E+06
	Median	1.49E+07	4.84E+07
	Range	1.04E+07	3.30E+07
	Minimum	6.16E+06	3.95E+07
	Maximum	1.66E+07	7.24E+07
^{134}Cs	Mean	5.11E+07	1.23E+08
	Standard Deviation	5.67E+06	1.01E+07
	Median	4.84E+07	1.19E+08
	Range	3.30E+07	6.05E+07
	Minimum	3.95E+07	9.73E+07
	Maximum	7.24E+07	1.58E+08
^{137}Cs	Mean	1.50E+11	1.55E+11
	Standard Deviation	7.75E+08	8.54E+09
	Median	1.51E+11	1.44E+11
	Range	3.51E+09	4.08E+10
	Minimum	1.48E+11	1.38E+11
	Maximum	1.52E+11	1.78E+11
^{154}Eu	Mean	2.46E+08	5.03E+08
	Standard Deviation	9.29E+07	1.69E+07
	Median	3.86E+08	4.89E+08
	Range	4.11E+08	9.73E+07
	Minimum	2.27E+05	4.65E+08
	Maximum	4.11E+08	5.62E+08
^{155}Eu	Mean	1.01E+08	1.40E+08
	Standard Deviation	4.73E+06	3.90E+06
	Median	1.01E+08	1.42E+08
	Range	9.46E+06	1.32E+07
	Minimum	9.68E+07	1.33E+08
	Maximum	1.06E+08	1.46E+08
^{3}H	Mean	5.83E+07	9.99E+07
	Standard Deviation	9.11E+06	7.07E+06
	Median	5.73E+07	9.70E+07
	Range	4.19E+07	3.76E+07
	Minimum	3.84E+07	8.16E+07
	Maximum	8.03E+07	1.19E+08

Table 12. (continued).

Radionuclide	Statistic	Tank WM-182 (pCi/L)	Tank WM-183 (pCi/L)
^{63}Ni	Mean	2.97E+04	4.36E+07
	Standard Deviation	7.31E+03	2.49E+06
	Median	2.29E+04	4.57E+07
	Range	3.01E+04	7.84E+06
	Minimum	2.15E+04	3.86E+07
	Maximum	5.16E+04	4.65E+07
^{237}Np	Mean	1.86E+06	5.76E+05
	Standard Deviation	8.72E+05	7.35E+04
	Median	1.79E+06	5.46E+05
	Range	3.23E+06	4.38E+05
	Minimum	3.11E+05	4.11E+05
	Maximum	3.54E+06	8.49E+05
^{238}Pu	Mean	3.14E+08	4.48E+08
	Standard Deviation	9.83E+06	5.07E+07
	Median	3.18E+08	4.19E+08
	Range	4.32E+07	2.73E+08
	Minimum	2.89E+08	3.16E+08
	Maximum	3.32E+08	5.89E+08
$^{239/240}$Pu	Mean	3.08E+07	1.37E+08
	Standard Deviation	1.18E+06	2.28E+07
	Median	3.01E+07	1.28E+08
	Range	5.14E+06	1.34E+08
	Minimum	2.89E+07	7.41E+07
	Maximum	3.41E+07	2.08E+08
Total Sr	Mean	6.93E+10	1.12E+11
	Standard Deviation	1.15E+09	5.11E+09
	Median	6.85E+10	1.09E+11
	Range	5.14E+09	2.76E+10
	Minimum	6.76E+10	9.70E+10
	Maximum	7.27E+10	1.25E+11

Table 13. Summary statistics for radionuclides in solids of WM-182 and WM-183 tank heels.

Radionuclide	Tank WM-182 (pCi/g)	Tank WM-183 (pCi/g)
^{241}Am	8.46E+05	2.45E+05
^{244}Cm	2.84E+03	Undetected
^{60}Co	1.04E+05	Undetected
^{134}Cs	7.43E+04	7.14E+05
^{137}Cs	4.24E+08	8.78E+08
^{154}Eu	Undetected	7.92E+05
^{3}H	1.19E+04	3.38E+04
^{237}Np	1.66E+03	1.76E+03
^{238}Pu	1.93E+07	4.00E+06
$^{230/240}$Pu	1.47E+06	1.25E+06
^{125}Sb	Undetected	3.35E+04
^{234}U	Undetected	3.38E+03
Total Sr	**232,000,000**	**185,000,000**

All analytes were detected in the liquid matrix of the WM-183 tank heel. However, the following analytes were measured at relatively small concentrations: antimony, arsenic, barium, beryllium, selenium, silver, thallium, and vanadium. Of those, arsenic, barium, selenium, and silver were present below the TCLP maximum concentration limits of 5.0 mg/L, 100 mg/L, 1.0 mg/L, and 1.0 mg/L, respectively.

In Tank WM-183 solids, the following analytes were not detected: beryllium, selenium, and vanadium. Concentrations of antimony, arsenic, barium, cobalt, and thallium were relatively small, with arsenic and barium present below the TCLP maximum detection limits of 5.0 mg/L and 100 mg/L, respectively.

3.4 Data Quality

The data generated from the post-decontamination characterization effort for the WM-182 and WM-183 tank systems will be used to evaluate parameters that are pertinent to the closure process. Each parameter to be evaluated requires data of specific quality. To demonstrate compliance with the closure requirements, the chemical and radiochemical measurement data obtained must be of high quality. Laboratory analytical procedures and laboratory data reporting will adhere to the following QA/QC standards with minor modifications:

- SW-846 for chemical data (EPA 1996)
- ER-SOW-163 for radionuclide data (INEL 1995b)

No modifications to the requirements for radionuclide analyses specified in ER-SOW-163 will be required. The tank, vault sump, DVB-C6, and cooling coil line residuals will be tested using EPA SW-846 methods, with minor modifications. The SW-846 methods will be followed as published except as modified by the SOWs used by the INEEL Sample Management Office (SMO). The INEEL SMO laboratory SOWs impose required QC, including corrective actions if a QC parameter is not within control limits that are more explicit than the published SW-846 methods. These QC requirements provide a more consistent data set for INEEL data users. The INEEL SMO SOWs require that the SW-846 method be performed as published (with specific QC requirements) unless modifications are required because of the radioactivity of the sample. It is anticipated that the residuals and rinsates will have a low enough radioactivity to allow normal processing of the sample. If the sample has higher radioactivity, smaller sample aliquots may be required to protect the health and safety of laboratory personnel. If an insufficient sample volume is collected from the tanks, vault sumps, or DVB-C6 because of limitations with sampling equipment, sample aliquots smaller than those called for in the SW-846 methods will also result. The effects of smaller sample aliquots is an adjusted detection sensitivity for the analytical methods. That is, a smaller aliquot results in a higher detection limit. In all cases where the sample aliquot is not as specified in the SW-846 methods, the laboratory will document the deviation in the sample analysis narrative provided with the data. The laboratory staff and their experience will be relied upon, in conjunction with the PM and PQAO, to make the best decisions for analyses where deviations may arise.

Tables 14 and 15 provide a summary of all analyses planned for the post-decontamination sampling effort of the WM-182 and WM-183 tank heels. The tables include the corresponding analytical method requirements for each analysis and the reporting procedure requirements when they differ from the analytical procedure. The laboratory will flag non-conforming data as appropriate and required in the analytical laboratory SOW.

Table 14. Summary of analysis requirements for solid residuals remaining in the WM-182 and WM-183 tank system components following decontamination.

Requested Analysis for Tanks WM-182 and WM-183 Solids	Analysis Method	Reporting Requirements
TCLP Analysis		
As, Ba, Cd, Cr, Pb, Hg, Se, Ag	USEPA SW-846 1311, 6010B, 7470A Hg	ER-SOW-156 Tier 1 Closure Plan
Total Metals		
Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Tl, V, Zn	3050B Sample Preparation 6010B 7471A Hg CVAA 7060A As GFAA 7740 Se GFAA	ER-SOW-156 Tier 1 Closure Plan
Radiochemical Parameters[a]		
^{241}Am, ^{14}C, ^{60}Co, $^{134, 137}Cs$, ^{129}I, ^{237}Np, ^{63}Ni, ^{90}Sr, ^{99}Tc, ^{94}Nb, $^{154, 155}Eu$, ^{244}Cm, $^{238, 239/240, 241}Pu$, $^{234, 235, 236, 238}U$	ER-SOW-163	ER-SOW-163 Tier 1 Closure Plan
Organic Analyses		
VOA[b], SVOA[c], methanol, pyridine and ethyl acetate, and cyclohexanone	USEPA SW-846 8260B VOA 8270C SVOA 88015B Methanol 8082 PCBs[d]	ER-SOW-169 Tier 1 Closure Plan

a. This list includes those key radionuclides that contribute significantly to the performance assessment, have readily available methods of analysis, and are described in DOE Manual 435.1-1 Chapter II (DOE 2001b).

b. VOA = Volatile organic analysis.

c. SVOA = Semivolatile organic analysis.

d. PCBs = Polychlorinated biphenyls.

Table 15. Summary of analysis requirements for liquid residuals remaining in the WM-182 and WM-183 tank system components following decontamination.

Requested Analysis for WM-182 and WM-183 Liquids	Analysis Method	Reporting Requirements
Total Metals		
Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Tl, V, Zn	3010A Sample Preparation (all elements except Hg) 6010B (all elements Hg) 7470A Hg	ER-SOW-156 Tier 1 Closure Plan
Radiochemical Parameters[a]		
^{241}Am, ^{14}C, ^{60}Co, $^{134, 137}Cs$, ^{3}H, ^{129}I, ^{237}Np, ^{63}Ni, ^{90}Sr, ^{99}Tc, ^{94}Nb, $^{154, 155}Eu$, ^{244}Cm, $^{238, 239/240, 241}Pu$, $^{234, 235, 236, 238}U$	ER-SOW-163	ER-SOW-163 Tier 1 Closure Plan
Wet Chemical Parameters		
Chloride, Fluoride, Nitrate, Phosphate, Sulfate	9056	ER-SOW-156 Tier 1 Closure Plan
pH	9040B or 9045C	
Organic Analyses		
VOA[b], methanol and SVOA[c] (Gilbert and Venneman 1999)[d], PCBs[e]	US EPA SW-846 8260B VOA 8270C SVOA 8015B Methanol by direct injection 8082 PCBs	ER-SOW-169 Tier 1 Closure Plan

a. This list includes those key radionuclides that contribute significantly to the performance assessment, have readily available methods of analysis, and are described in DOE Manual 435.1-1 Chapter II (DOE 2001b).

b. VOA = Volatile organic analysis.

c. SVOA = Semivolatile organic analysis.

d. *A Regulatory Analysis and Reassessment of U.S. Environmental Protection Agency Listed Hazardous Waste Numbers for Applicability to the INTEC Liquid Waste System*, INEEL/EXT-98-01213, Rev. 1, Idaho National Engineering and Environmental Laboratory, Idaho Falls, Idaho, February.

e. PCBs = Polychlorinated biphenyls.

4. DOCUMENTATION AND DATA MANAGEMENT

Documentation involves the recording of all events relating to field and laboratory activities. Typical field documentation will include field logbooks, sample labels, and COC forms. Sample handling procedures include COC, radiological field screening, sample- and investigation-derived waste packaging, and transport of samples to the laboratory.

4.1 Documentation

To ensure that all sampling, analysis, and data reporting activities are conducted in accordance with project DQOs and all appropriate safety procedures, adequate documentation of each event must be completed. Therefore, all field activities related to sample collection, site safety, and sample custody must be recorded by the FTL or the field team members in the field logbook. In addition, all laboratory activities relating to sample custody, sample preparation, sample analysis, and data reporting must also be completely recorded to ensure that laboratory data can be confidently assigned to field sample points. The PE will observe sampling activities and will be provided with the logbooks, COC forms, analytical results, and any other documentation generated during closure activities that is required to certify the closure.

The laboratory will perform all functions required for Tanks WM-182 and WM-183 samples in accordance with an appropriate laboratory QAP. In addition, project management and other key project staff may contact the laboratory personnel and obtain a copy of the laboratory QAP and/or visit the facility to ensure that laboratory procedures meet the project-specific goals.

4.1.1 Field Operations Records

The following subsections provide a summary of requirements for adequate field documentation. All field documentation, document control, and daily updating of field logbooks and field materials will be the responsibility of the FTL or designee.

4.1.1.1 Sample Container Labels. Following sample collection and prior to transport to the laboratory, each sample taken will be evaluated for radiation levels. This evaluation will be performed to determine whether the sample will be split prior to transport to the laboratory or whether the entire sample will be transported uncut to the laboratory. The result of this decision will be recorded on the COC which accompanies the sample to the laboratory. This COC will also document sample splits to be performed and provide field identifiers for the shipped sample and field identifiers to be assigned to sample splits created within the laboratory.

If the entire sample is transported to the INTEC Remote Analytical Laboratory (RAL) in a single container then the bulk of sample labeling will occur at the RAL when the samples are split as liquids or solids or when sub-samples are created for separate analyses. Sample splits created within the laboratory will be tracked using laboratory internal tracking forms and/or logbook entries.

If attaching labels is difficult because of high radiation fields, the sample will be tracked using COC forms and/or entries into the project logbook. As a result, the following five entries are required to be placed on both the high-density polyethylene (HDPE) container within the sampler housing and on the sampler housing itself:

1. Project name

2. Name, or initials, of sampling team member

3. Date of sample collection

4. Analysis request(s)

5. Field identification number.

NOTE: Time of sample collection will be recorded in the field logbook.

This procedure will be repeated each time a sampling team member draws a sample from the WM-182 and WM-183 tanks with the simple sampler, LDUA, or other appropriate sampling equipment. Following transport of the sample and the shielded sample vessel to the RAL, the RAL SC will retain custody of the samples. The RAL then will be tasked with segregating the liquid phase of the sample from the residual solids and separating two aliquots of each sample as follows:

- A portion of each phase shall be placed in a container for organic analysis taking care to minimize aeration of the sub-sample and move the sub-sample to cold storage as soon as possible.

- For all other requested analytes, the remainder of each phase shall be apportioned as follows: The lab will separate liquids and solids into separate sample containers based on the volume or mass necessary for each analysis or analysis type required.

Samples and sample splits will be labeled, recorded, and tracked according to Section 4.1.1.3.

The following specific information will be placed on the sample label for each media type, and each split of the bulk sample, and recorded on the COC or internal tracking forms:

- Project name

- Date of sample collection

- Time of sample collection

- Name of sampling team member

- Analysis request(s)

- Radiological field measurement

- Field identification number

- Unique laboratory sample identification number.

If radiation levels are low enough to allow sample apportionment in the field, pre-labeled bottles will be used for sample collection. The sampling team member will enter the following information on the sample label:

- Date of sample collection

- Time of sample collection

- Name of sampling team member

- Analysis request(s)
- Radiological field measurement
- Field identification number.

Each sample will be assigned a unique identification number. A systematic character identification code will be used to identify the samples. Uniqueness is required for maintaining consistency and preventing the same identification code from being assigned to more than one sample.

4.1.1.2 Field Sampling Logbooks. Field logbooks are legal documents; they are the written record for all field data gathered, field observations, field equipment calibrations, samples collected for laboratory analysis, and sample custody. The logbooks are maintained to ensure that field activities are properly documented as they relate to site safety meetings and that site work is conducted in accordance with the health and safety procedures. Field logbooks will be bound, and they will contain consecutively numbered pages. All entries in field logbooks will be made using permanent ink pens or markers. All mistakes made as entries will be amended by drawing a single line through the entry and then initialed and dated by the person making the correction. At a minimum, the following entries will be made to the field logbook:

- Identification of all sampling team members
- References to field methods used to obtain samples, field data, etc.
- Location and description of each sampling point
- Types, numbers, and volumes of samples (when observable)
- Date of sample collection, time of sample collection, and sample identification
- Date and time of sample shipping, or transfer of sample custody
- Observed weather conditions
- All field measurements
- Any deviations from the standard or expected procedure
- COC form numbers and copies of the COC forms.

4.1.1.3 Chain of Custody Record. COC procedures will begin immediately after collection of the first sample. At the time of sample collection, the sampling team will initiate a COC form for each sample. All samples collected will then remain in the custody of a member of the sampling team until custody is transferred to the laboratory SC. Upon receipt at the laboratory, the SC will review sample labels and the COC form to ensure completeness and accuracy. If discrepancies are noted during this review, immediate corrective action will be sought with the sampling team member(s) identified on the COC as delivering the samples. If errors cannot be corrected with the sampling team members, the PQAO or the PM will be sought to correct sample labeling or COC errors.

Pending successful corrective action, the laboratory SC will sign and date the COC form signifying acceptance of delivery and custody of the samples. The sampling team will retain the original signed

COC and will note the time of sample custody transfer in the field logbook. Sufficient copies of COCs will be made at the time of sample delivery to ensure that appropriate personnel have copies. The laboratory will maintain possession of the original COC form until completion of sample analysis and will maintain one of the three COC copies for the term of data storage at the laboratory. Only at the time of disposal of laboratory data, or transfer to the HLW Program ARDC, will the original COC form leave the laboratory's control. The original COC form will be returned to the project file maintained by the PM or the PQAO along with the final data package deliverable.

The method of apportioning samples into appropriate sample containers and placement in shipping containers will depend on the radiation levels in the field samples. If the samples contain radioactivity at levels that preclude manipulation of the sampled media in the field, the samples will be transported to the INTEC RAL so the appropriate sample aliquots can be obtained. Because of the potential for solid separations and the need to perform sample splitting for various analyses, the laboratory will generate a sample apportionment and compositing record and various internal aliquot tracking records at the time of sample aliquot/split handling. This record will allow the samples to be clearly tracked when portions of the original sample become segregated and/or composited before shipment to the analytical laboratory performing the required analyses. Specific information that will appear on each internal tracking record for a sample or group of samples will include:

- Sample numbers specific to sample location and media (i.e., the Field Identification Number)
- The unique sample identification number assigned to each aliquot obtained from the original field sample
- Printed form and signatures of sampling team members handling the sample
- Dates and times of aliquot/split preparation for each sample (the time entry is necessary only if the holding time is two days or less)
- Signature of any person who has maintained sample custody for any period
- Dates and times of sample possession for each person holding sample custody (the time entry is necessary only when the holding time is two days or less)
- Analyses requested for each sample and each phase
- Number of bottles of each sample.

If a laboratory other than the RAL will be performing the analyses on the sample aliquots, a new COC form will be prepared showing the sample identification numbers for the various aliquots and the requested analyses. The laboratory person responsible for preparing the sample aliquots will be listed on the COC. The RAL SC will then sign the form indicating relinquishment of custody prior to receipt by the analytical laboratory performing the analyses. This new COC form will be transferred with the sample aliquots to the analytical laboratory performing the analyses, signed by the laboratory SC, and a copy returned to the COC records coordinator identified in the analytical laboratory SOW. Copies of the internal tracking record will be retained at the RAL, the PQAO, and the PM and submitted to the HLW Program ARDC at the same time as the analytical data.

4.1.2 Laboratory Records

Laboratory records are required to document all activities involved in sample receipt, processing, analysis, and data reporting. The following section describes the laboratory records that will be generated for this project.

4.1.2.1 Sample Data. These records contain the times that samples were analyzed to verify that they met holding times prescribed by the analytical methods. Sample data records should include information on the total number of samples analyzed in a given day, location of sample analysis (i.e., instrument identification number), any deviations from analysis SOPs and/or methods, and time and date of analysis. Corrective action steps taken to rectify situations that did not conform to laboratory SOPs and/or analytical methods (including steps taken to seek additional sample material if required) should also be noted in these records.

4.1.2.2 Sample Management Records. Sample management records document sample receipt, handling and storage, and scheduling analyses. The records verify that the COC and proper preservation were maintained, reflect any anomalies in the samples (such as receipt of damaged samples), note proper log-in of samples into the laboratory, and address procedures used to prioritize received samples to ensure that holding time requirements will be met.

4.1.2.3 Test Methods. Unless analyses are performed exactly as prescribed in the analytical methods or laboratory SOPs, this documentation describes how the analyses were performed by the laboratory. Items to be documented include sample preparation and analysis, instrument standardization, detection and reporting limits, and test-specific QC criteria. Documentation demonstrating laboratory proficiency with each method used could also be included in this category.

4.1.2.4 QA/QC Reports. These reports will include general QC records, such as initial demonstration of capability of individual analysts to conduct specific analyses, instrument calibration, routine monitoring of analytical performance (e.g., control charts), and calibration verification. Project-specific information from the QA/QC checks such as blanks (e.g., field, reagent, and method), spikes (matrix, matrix spike duplicate, and surrogate), calibration check samples (e.g., zero check, span check, and mid-range check), replicates, and splits should be included in the QA/QC reports to facilitate data quality analysis. Specific requirements for the quantity and types of QA/QC monitoring and associated reporting formats will be specified in the analytical SOW to the laboratory.

4.2 Document Control

Document control consists of the clear identification of all project-specific documents in an orderly form, secure storage of all project information, and controlled distribution of all project information. Document control ensures controlled documents of all types related to the project will receive appropriate levels of review, comment, and revision as necessary. It also ensures that all documents that will ultimately affect project QA are correct before use.

The PM is responsible for properly maintaining active project files. Upon completion of the WM-182 and WM-183 post-decontamination tank system characterization, the PM will transfer all hard-copy information and documentation developed from the project to the HLW Program ARDC for appropriate archiving. Hard-copy information and documentation include field logbooks, field and laboratory COC forms, laboratory reports and data, engineering calculations and drawings, final design reports, and all other technical reports related to the project. Copies of all analytical data and final reports will also be retained in the laboratory files and, at the discretion of the laboratory manager or QA officer, will be stored on computer disk and in hard-copy form for a minimum of five years from point of

generation. Data will be made available for retrieval by authorized project staff from the HLW Program ARDC and the laboratory archives upon request.

4.3 Data Management

Data management consists of controlling the data generated and other data collected for use (e.g., existing data) during this sampling and analyses effort. All data will be controlled using the document control processes described in Section 4.2 and in accordance with all existing MCPs concerning control and archival of electronic data. Data will be made available for retrieval by authorized project staff from the HLW Program ARDC and the laboratory archives upon request.

5. SAMPLING PROCESS DESIGN

Sample handling for the post-decontamination characterization effort for the WM-182 and WM-183 tanks will require a series of special procedures because of the potential to encounter high radiation fields in the samples and the high levels of other hazardous constituents. The following subsections outline the specific sampling process design for this effort.

5.1 Sample Collection

The overall purpose of the Tanks WM-182 and WM-183 post-decontamination sampling and analysis effort is to provide data that will be used to determine if the TFF decontamination activities have resulted in the HWMA/RCRA closure standards being met.

The HWMA/RCRA performance standards include demonstrating that no hazardous waste remains in the closed unit (i.e., the TFF) and incorporating the risk-based approach to clean closure of RCRA units. The recommended risk from carcinogens is 10^{-4} using EPA default exposure parameters and a hazard quotient of 1 for noncarcinogens. DOE closure requirements are based on the PA criteria (a dose limit of 25 mrem/year to an off-site receptor) found in DOE Order 435.1 (DOE 2001a).

Samples of the WM-182 and WM-183 post-decontamination tank system residuals must be collected and analyzed for a specific group of parameters to satisfy HWMA/RCRA and DOE requirements for TFF site closure. Previous sampling efforts undertaken during process operations and in the initial characterization sampling have yielded some process-specific data. However, these data only pertain to liquids present in the tank during sampling; therefore, these data are not applicable for determining the contributions of the post-decontamination concentrations in the tanks in meeting the criteria for closure of the TFF under HWMA/RCRA or DOE Order 435.1. No data exist regarding the post-decontamination concentrations of RCRA constituents and radionuclides in tank residuals. Therefore, sampling the post-decontamination residuals is required to obtain these data.

5.1.1 Pre-Sampling Meeting

Before sampling takes place, project personnel will meet to ensure the sampling and analysis can be performed in a safe manner and that the sampling and analysis will provide the project with usable data. The following personnel are expected to be present at the meeting: the sampling team, a laboratory representative (required only if it is anticipated that sample apportionment will take place in the RAL), the PQAO, health and safety personnel, project management, the EA Closure PM, an independent PE, and personnel responsible for risk and dose assessments.

Sampling team members must be experienced in operation of the simple sampler, LDUA, or other appropriate sampling equipment and other aspects of sampling the TFF tanks. They will be trained in the procedures for operation of the chosen sampling equipment as well as appropriate INTEC and INEEL ES&H procedures and policies. The senior personnel will be familiar with the TFF systems and components.

5.1.2 Sample Location and Frequency

The nature of the sample matrix and the method of collection may place limitations on sampling and analytical design. For example, if the samples from the tanks are to be collected with a simple sampler or an LDUA device, additional sample screening and manipulation activities will be required in the field or in the RAL prior to final transport of the sample to the analytical laboratory. Samples may be collected using sampling equipment other than the simple sampler or LDUA.

The simple sampler will take one sample from each of the three risers on each tank (Figure 4). Then, the tank contents will be agitated again and two more samples will be taken by collecting one sample from two of the three risers on each tank. The two additional samples will be collected from two risers chosen randomly. This will result in a total of five samples from each tank. The risers to be sampled from are:

- WM-182: TR-19, TR-51, TR-52, TR-51, TR-52
- WM183: TR-13, TR-53, TR-54, TR-53, TR-54

The LDUA can only retrieve samples from one riser in each of the tanks (TR-51 in WM-182 and TR-54 in WM-183). Therefore, if the LDUA is used, samples will be collected from five randomly selected locations within the reach of the LDUA (Figures 5 and 6).

If an alternative sampling device is used, it may not have the ability to reach the number of sampling locations described in this section. If such a limitation is identified, an alternative random sampling design will be devised for the sample collection device selected. This revised random sampling design will be documented in a revision to this SAP. The remainder of this section assumes the simpler sampler or LDUA will be used to collect samples from the tanks.

The sample chamber of the simple sampler has an approximately 250 ml collection capacity. Sample volumes may be as small as 50 ml of media per sampling effort (i.e., trip into the tank). The maximum amount of sample volume possible will be collected each time the simple sampler is lowered into the tank. Due to the likelihood of a small sample volume and the limited percentage of solids in the sample matrix, collection of a sufficient amount of solid to perform all of the required analyses may be difficult. The SAP assumes that decontamination will be complete enough that any solids remaining in the tank will be considered residuals for which characterization is not required. If less than 15% of the sample volume recovered is solid, the assumption will be made that the solid fraction is inconsequential to the decisions being made relative to closure.

The sample chamber of the LDUA has a 1,200 ml collection capacity. Sample volumes may be as small as 200 ml of media per sampling effort (i.e., trip into the tank). The maximum amount of sample volume possible will be collected each time the LDUA is lowered into the tank. Due to the likelihood of a small sample volume and the limited percentage of solids in the sample matrix, collection of a sufficient amount of solid to perform all of the required analyses may be difficult. The SAP assumes that decontamination will be complete enough that any solids remaining in the tank will be considered residuals for which characterization is not required. If less than 15% of the sample volume recovered is solid, the assumption will be made that the solid fraction is inconsequential to the decisions being made relative to closure.

When less than 15% of the volume of the sample collected is solid material, the solid fraction will be filtered at the analytical laboratory (after sample aliquots are collected for VOC analyses) and discarded. Solid samples are included in the previous and remaining sections of the SAP only for the contingency that solids are present at greater than 15% of the total volume of the samples collected from the tanks. Preliminary estimates assume that 1.0 in. of the heel will remain after decontamination. If 15% of this amount is solid, then 0.15 in. of solids will remain in the tank. If greater than 15% solids remain in the tank following decontamination, a decision on whether or not to continue to decontaminate the tanks to attempt to reduce the solids content will be made. As samples are collected, the percentage of solids in each sample collection container will be measured by measuring the depth of solids in each container relative to the total sample depth.

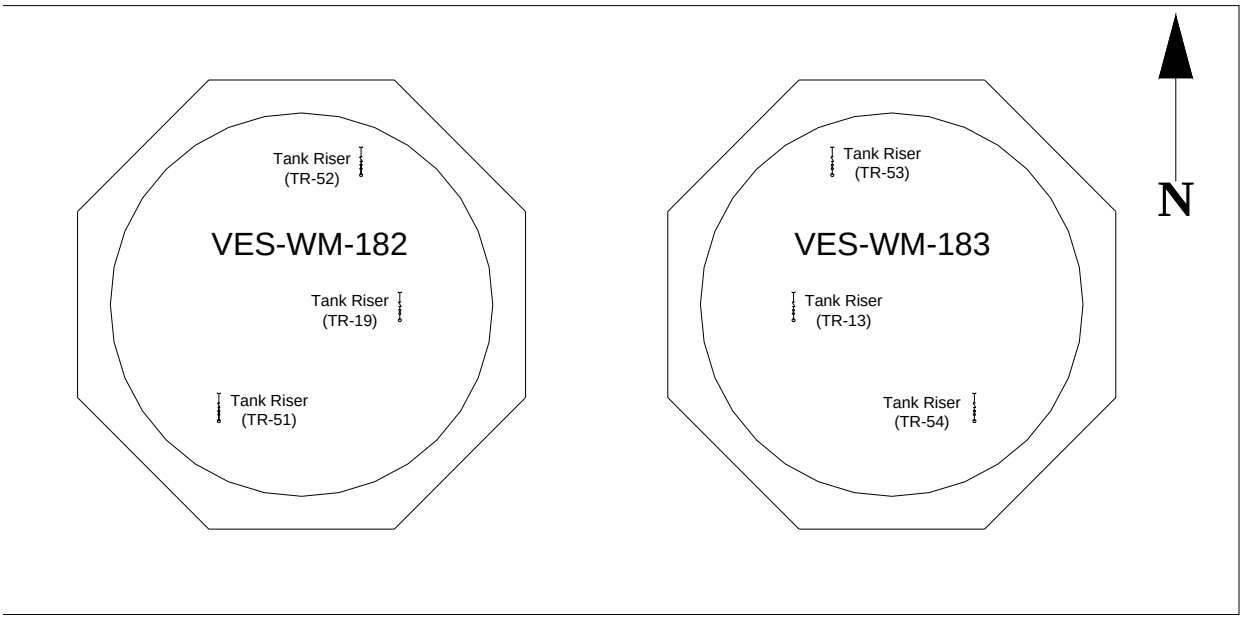


Figure 4. Riser locations where samples will be collected.

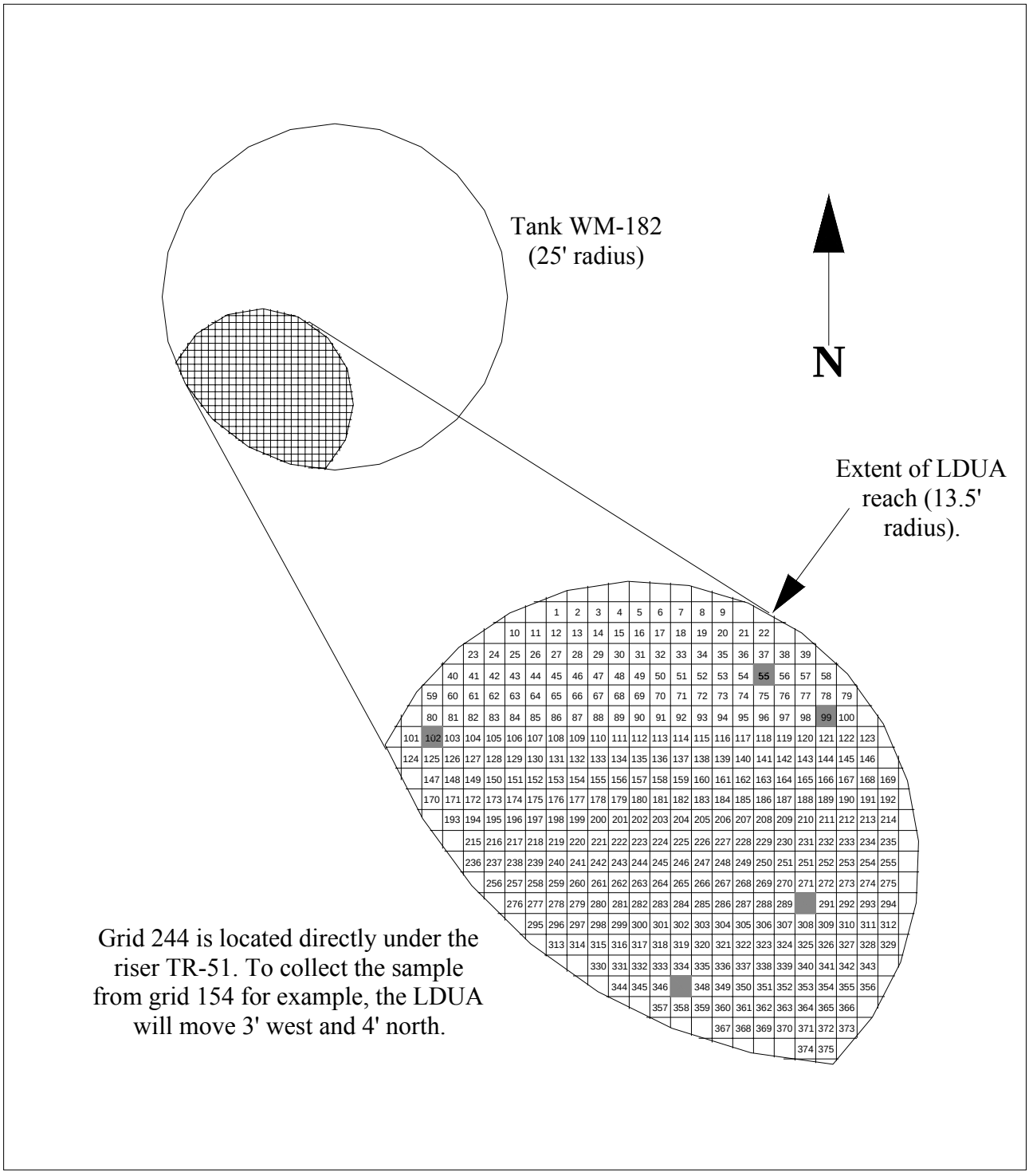


Figure 5. Sample locations for Tank WM-182.

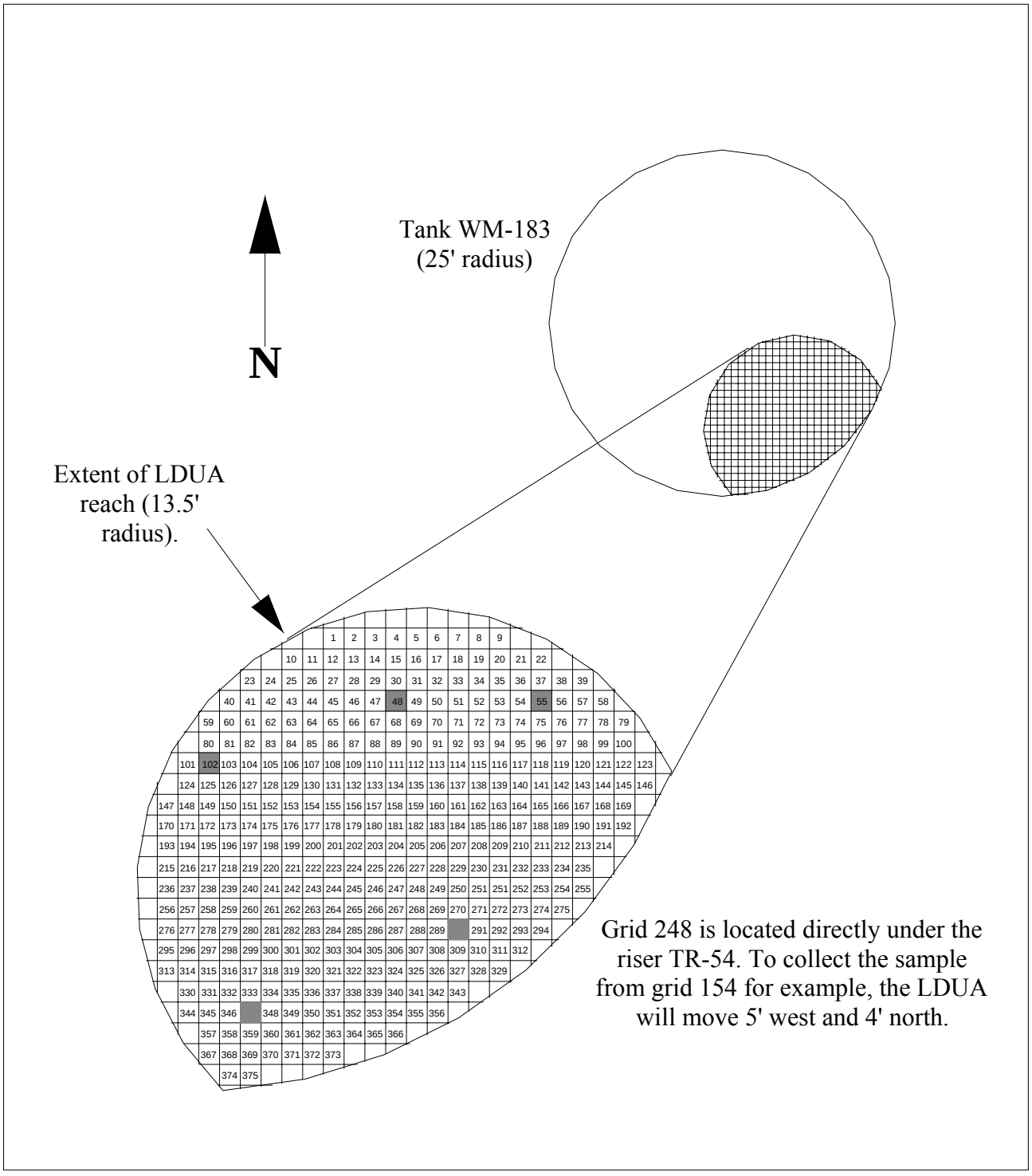


Figure 6. Sample locations for Tank WM-183.

The simple sampler can reach only the residual directly beneath the riser. The LDUA can effectively reach approximately 21% of the tank bottom in WM-182. The LDUA can reach locations within a 13.5-ft radius of the opening into which it is lowered. The samples will be inspected for color, light transmission, wet weight of solids, and other qualitative indicators either when they are transferred to the hot cell in the RAL or in the sample apportioning staging area. These characteristics of the samples will be recorded by the sampling team members to provide project documentation concerning the completeness of removal of the former tank heel. Radiation fields will be measured when the sample is removed from the tank. The radiation measurements will be used to determine if the samples can be apportioned in the field or if remote handling will be required for apportioning.

Enough sample material will be collected using the simpler sampler or LDUA to fill the number of bottles required to complete the analyses (see Tables 16 and 17). Since the residual will be agitated prior to sampling, it is reasonable to assume that the liquid in the tank is homogenous. Therefore, even though sample locations cannot be selected at random, potential samples are randomly distributed throughout the tank. Thus, a simple random sampling method can be assumed for sampling with the simple sampler or the LDUA. In the case of the LDUA, the area that the LDUA can reach has been divided into 1-ft grids (Figures 5 and 6). A random number table was used to select five of these grids for sample collection. This has been done to ensure that samples are independent. The LDUA can be controlled to ensure return trips are made to each of the five locations until enough sample material is collected for each analysis. The actual sample locations will depend on the reach of the LDUA and whether or not tank components (e.g., cooling coils) interfere with sample collection. If tank structures interfere with collection of a sample in one or more of the specified locations, the next applicable grid collection locations are:

- For WM-182: 48, 167, 33, 91, 310, 152, 317, 131, 279, 239, 210, and 237
- For WM-183: 99, 33, 233, 346, 340, 150, 167, 230, 322, 80, 131, 274, and 354.

Attempts will be made to collect samples at the next grid locations in the order specified in this SAP. This method will ensure that random sampling statistics can be used in evaluation of the data obtained. If additional sample volume from one grid location is needed, the determination will be made by the PM. If the volume collected for analysis is inadequate, additional sample volume will be collected.

Samples will be collected using the volume method where the sample is collected with the simple sampler nose or LDUA end effector (EE) positioned slightly above the tank bottom. This is performed to maximize collection of tank contents (volume of sample collected). The volume method of sample collection may result in collection of solids that may remain on the tank bottoms following decontamination activities. All samples will be collected using the volume method if the PM approves.

If repeated decontamination attempts fail to reduce the volume of solids remaining in the tanks to less than 15% of the total volume, the solid portion of the sample will be analyzed for hazardous constituents. Regardless of the relative volume of solid material present in the sample, a sample of the solids must be analyzed for radionuclides to provide data for decisions relative to DOE Tier 1 closure (see footnote c, page 11).

For solid sample collection at one location, the individual sample aliquots will be decanted in the laboratory and the solids will be combined for a composite sample of the solids from that location. If hazardous constituent analyses are required, this composite sample will be analyzed as a single sample representing each of the locations where greater than 15% solids are present. An estimate of the relative volumes of the liquid and solid phases will be made to apply the TCLP calculations for total analyte concentration, as discussed previously. If only radionuclide analyses are required (i.e., the volume of solid is < 15%), the individual aliquots will be composited in a jar of appropriate geometry for the gamma

Table 16. Summary of sample collection, holding time, and preservation requirements for radiological analyses.

Analysis	Sample Matrix	Approximate Volume[a] (L)	Container Type	Holding Time[c]	Preservative
Alpha Spectrometry					
Americium (^{241}Am)	Water	1	HDPE[b]	# 6 months	HNO_3 to pH < 2
Curium Isotopes (^{244}Cm)	Water	1–2	HDPE	# 6 months	HNO_3 to pH < 2
Neptunium (^{237}Np)	Water	1	HDPE	# 6 months	HNO_3 to pH < 2
Plutonium Isotopes ($^{238, 239/240, 241}$Pu)	Water	1	HDPE	# 6 months	HNO_3 to pH < 2
Uranium Isotopes ($^{234, 235, 236, 238}$U)	Water	1	HDPE	# 6 months	HNO_3 to pH < 2
Gamma Spectrometry					
Project-specific Target analytes: (^{60}Co, ^{134}Cs, ^{137}Cs, ^{94}Nb, $^{154, 155}$Eu)	Water	0.5–2	HDPE	# 6 months	HNO_3 to pH < 2
Gamma spectroscopy and α/β-radiochemistry	Residual Solids	16 oz	Wide-mouth plastic jar[b]	Analyze within 6 months[b,c]	None
Specific Analysis					
Carbon (^{14}C)	Water	0.3–1	HDPE	# 6 months	None
Iodine (^{129}I)	Water	1	Amber-colored Glass[d]	# 6 months	None
Nickel (^{63}Ni)	Water	0.5–1	HDPE	# 6 months	HNO_3 to pH < 2
Plutonium (^{241}Pu)	Water	1	HDPE	# 6 months	HNO_3 to pH < 2
Strontium (^{90}Sr)	Water	0.5–1	HDPE	# 6 months	HNO_3 to pH < 2
Technetium (^{99}Tc)	Water	0.5–2	HDPE	# 6 months	HNO_3 to pH < 2
Tritium (^{3}H)	Water	0.1–0.5	HDPE/Glass[e]	# 6 months	None

a. Volumes vary depending on the requested analysis and the laboratory performing the analysis. Exact volumes required will be specified to project personnel following final determination of the analytical services provider. Any additional volume to allow for analysis of duplicates required by the analytical method will also be specified by the laboratory prior to sampling.

b. HDPE = High-density polyethylene.

c. The holding time requirement of six months is described in 40 CFR 136 (EPA guidelines for analysis of pollutants) and is applied as a general guideline. For analysis of volatile radionuclides not listed above or radionuclides with short half-lives (e.g., ^{131}I), the holding times will be adjusted accordingly and disseminated to the laboratory via a project-specific statement of work.

d. Collecting samples for ^{129}I in HDPE containers is permissible/acceptable; however, the holding time requirement is 28 days (instead of 6 months).

e. Samples containing high levels of tritium (^{3}H) must be collected in glass containers. High-level ^{3}H is defined as concentrations that exceed 10^{4} pCi/L.

Table 17. Summary of sample collection, holding time, and preservation requirements for non-radiological analyses.

Analysis	Sample Medium	Volume[a]	Container Type[b]	Holding Time	Preservative
Anions	Residual Solid	250 mL	Wide-mouth glass jar	28 days[h]	4ºC[h]
Anions	Water	500 mL	HDPE bottle	Analyze within 48 hours for NO_3 and PO_4. All others within 28 days[h]	4ºC[h]
Methanol	Water	1 × 40 mL[e]	40-mL glass vial, Teflon-lined cap	Analyze within 14 days[c]	4ºC (add H_2SO_4, HCl or $NaHSO_4$ to pH < 2 as necessary)[c]
PCBs	Water	1,000 mL[e]	Amber-colored glass jugs	Extract within 7 days, analyze extracts within 40 days of extraction[c]	4ºC[c]
pH	Water	60 mL	HDPE	Analyze as soon as possible[h]	None
TCLP Metals	Residual Solid	500 mL	Wide-mouth glass jar, Teflon-lined cap	For metals, except Hg: (a) complete TCLP extraction within 6 months; and (b) complete determinative analysis (DA) within 6 months of TCLP extraction. For Hg: (a) complete TCLP extraction within 28 days; and (b) complete DA within 28 days of TCLP extraction[c]	4ºC[c]
Total Metals	Residual Solid	125 mL	Wide-mouth glass jar	Analyze within 6 months, except Hg analyze within 28 days[c]	4ºC[c]
Total Metals	Water	1,000 mL	HDPE bottle	Analyze within 6 months, except Hg analyze within 28 days[c]	HNO_3 to pH < 2[c]
Total SVOCs[f]	Water	1,000 mL[e]	Amber-colored glass jugs	Extract within 7 days, analyze extracts within 40 days of extraction[c]	4ºC[c]
Total SVOCs[f] and PCBs[g]	Residual Solid	250 mL	Wide-mouth glass jar	Extract within 14 days, analyze extracts within 40 days of extraction[c]	4ºC[c]
Total VOCs[d]	Water	2 × 40 mL[e]	40-mL glass vial, Teflon-lined cap[e]	Analyze within 14 days[c]	4ºC (add H_2SO_4, HCl or $NaHSO_4$ to pH < 2 as necessary)[c]
Total VOCs[d]	Residual Solid	125 mL	Wide-mouth glass jar	Analyze within 14 days[c]	4ºC[c]

a. Volumes may vary depending on the requested analysis and the laboratory performing the analysis. Exact volumes required will be specified to project personnel following final determination of the analytical services provider. Any additional volume to allow for analysis of quality control samples required by the analytical method will also be specified by the laboratory prior to sampling. The minimum volume required to meet the required detection limits will be collected for each analysis to ensure personnel radiation exposure is maintained ALARA.

b. It is highly recommended that a certificate of cleanliness be obtained for all lots of sample containers used.

c. EPA SW-846 Chapter 2.

d. VOC = Volatile organic compound.

e. Once each 20 samples or 14 days, whichever comes first, 3 times the normal sample volume is required (e.g., 3,000 mL instead of 1,000 mL, 6 H 40 mL instead of 2 H 40 mL, etc.).

f. SVOC = Semivolatile organic compound.

g. PCB = Polychlorinated biphenyl.

h. EPA (1983) *Methods for the Chemical Analysis of Water and Wastes,* EPA/600/4-79/020, March.

spectroscopy and radiochemical analyses required. Gamma spectroscopy, which is a non-destructive analytical technique, will be conducted first, after which the radionuclide analyses in which the sample is consumed will be performed.

More than one simple sampler or LDUA sampler volume will be needed to fill all the bottles required to complete the specified sample analyses. The simple sampler or LDUA will be returned to the selected locations on each trip until adequate volume to fill the required sample containers is collected. The simple sampler or LDUA will then begin collecting sample material at the second sampling location, making enough trips until adequate volume for that location is retrieved. This process will be repeated at all five sample collection locations in the tanks. The sample apportionment process will assume a relatively homogenous liquid sample material is being retrieved from the tank. Therefore, no sample compositing of liquids will take place during the sample apportionment process unless it is required to ensure adequate sample volume for analysis. The individual bottles will be filled directly from the simple sampler or LDUA sample collection vessel as the liquid sample material is retrieved.

Samples of post-decontamination rinsate from the DVB-A5 and -A6 will be allowed to drain into the vault sumps, where a sample will be collected. Because liquids drain from DVB-C6 to a different location, a sample of rinsate solution will be taken from the residual liquid remaining in the DVB-C6 sump after the majority of the rinsate drains to DVB-C12. Each valve box is decontaminated individually in the closure decontamination sequence. In addition, a final rinse of the vault floor for each of the tanks will be allowed to flow into the vault sump, and a sample of the combined rinsate solutions will be collected.

Samples from the cooling coils will be collected using the existing sample collection systems for these lines in CPP-628. Decontamination fluids will be collected from 5 of the 60 cooling coils in each tank. The sample locations were chosen using a random numbers table to ensure that random sampling statistics can be applied to the data collected. The sample locations are as follows:

- For Tank WM-182: cooling coils 214, 23, 30, 31, and 49
- For Tank WM-183: cooling coils 18, 26, 35, 56, and 58

(The cooling coils refer to the order in which rinsate is passing by the sample collection valve in CPP-628. That is, the first cooling coil cleared is 1, the second 2, etc.)

5.1.3 Sample Preservation

Sample preservation is conducted to ensure that target analytes do not escape from field samples or become chemically attached to sample containers before analysis. Typical sample preservation activities include the addition of acids to ensure that metals and radionuclides remain in solution and to inhibit biological activity that could affect organic constituents. To prevent volatile and semi-volatile materials from escaping sample media, field samples are cooled with ice or blue ice.

If radioactivity levels in the samples require delivery to the RAL before preservation, it is expected that the turnaround of samples from collection to delivery at the RAL will be a very short period of time (a matter of minutes). On receipt at the laboratory, the materials will be split and placed in coolers on ice. Ice or blue ice used to cool samples may become an investigation-derived waste after contact with WM-182 and WM-183 radiation fields and other hazardous constituents. If so, it must be managed thereafter as a waste form. Therefore, if the samples will be transported to the RAL before apportioning, ice will not be used to cool the samples between collection and delivery to prevent creation of additional

waste. It is recognized, however, that due to the high temperatures in the tank and in the hot cell, the volatile organic analysis (VOA) and semivolatile analysis (SVOA) data will be low biased.

During sample apportioning, the sampling team member or RAL analyst will first transfer sufficient liquid for the determination of VOCs to two 40-ml glass vials for each sample and samples collected for methanol to one separate 40-ml glass vials (as defined in Chapter 2 of SW-846 and listed in Table 17). For those liquid samples to be used for VOC determination, the sampling team member or analyst will ensure that no head space remains in the sample vials after the caps are placed on them, and the team will ensure the liquid is agitated as little as possible during transport. Head space is checked by inverting the bottle and lightly tapping on the lid to ensure no bubbles are visible in the container. The samples will then be labeled and cooled.

The sampling team member or RAL analyst shall inspect the individual sample matrices generated during the apportionment process to determine if each sample phase contains sufficient material to perform the requested analyses. The individual matrices must be placed in glass or HDPE containers and preserved as described in Tables 16 and 17 prior to transport to the laboratory performing the analyses. It is anticipated that the sample containers described in Tables 16 and 17 can be filled directly from the sample collection valves in CPP-628 for samples collected from cooling coils.

5.1.4 Field Radiological Control Screening

Because of the potential intensity of radiation fields at Tanks WM-182 and WM-183, all sampling and analysis activities will comply with INEEL MCPs and, potentially, RAL SOPs. The radiological controls and personnel monitoring requirements established for simple sampler, LDUA, or other appropriate sampling equipment operation, and the subsequent sample transfer, are based on radiation exposure rates calculated using process data obtained during the operation of Tanks WM-182 and WM-183. These exposures rates will be used to implement action levels that will help to ensure that all work activities and personnel exposure to direct radiation are maintained as low as reasonably achievable (ALARA) (INEEL 2000a). If the action levels are low enough, field manipulation of sampled material may proceed in the sample collection staging area.

In addition to monitoring for personnel exposure, the sampler EE will also be directly monitored at several points throughout the collection process to make decisions relative to whether the samples must be delivered to the RAL for sample apportionment or if they can be manipulated by sampling team members in the field. Two separate means of monitoring the radiation field associated with the samples will be used. First, telemetry dosimeters with remote read-out capabilities will be placed in locations that will be readily exposed to the radiation field during sample extraction. Secondly, following an evaluation by the IH, the RCT will use hand-held instrumentation to screen beta and gamma radiation in the sample collection port.

These direct radiation screenings will be used to determine whether the sample is suitable for handling and apportioning activities or if it must be prepared for transport and delivery to the RAL. All activities relating to the post-decontamination characterization of the WM-182 and WM-183 tank systems will be done in accordance with requirements of PRD-183, “INEEL Radiological Control Manual,” (INEEL 2000a). It is anticipated that radiation levels will be low enough from samples collected from cooling coils in CPP-628 that the sample containers can be directly filled from the sample collection ports.

5.1.5 Sample Containers

It is possible that all samples from the tanks, vault sumps, and the DVB-C6 will be collected in the simple sampler or LDUA sample chamber. The LDUA sampler employs vacuum pressure to draw materials into a HDPE container placed in the center of the housing. The simple sampler employs vacuum pressure to draw materials into a stainless steel tube. Approximately 200 ml of solid/liquid mixture will likely be obtained during each simple sampler or LDUA trip. If the LDUA is used at Tanks WM-182 and WM-183, samples will be collected from the residuals present in the tank heels using the HDPE container, placed in a shielded housing. If the simple sampler is used appropriate shielding will be used after the sampler is retrieved from the riser. The use of these types of samplers introduces the potential for data usability limitations for organic analyses. Specifically, the use of a vacuum to draw a sample for VOAs could result in an unquantifiable loss of analytes of interest. However, the loss of analytes attributable to the use of the vacuum collection system is likely negligible compared to the loss resulting from the highly acidic and elevated temperature conditions of the waste in the tank. The use of an HDPE bottle could introduce levels of phthalate esters such that dilution of the sample would be required during analysis for SVOCs. The data obtained from the initial characterization analyses of the WM-182 tank heels indicate that, although phthalate esters were detected in the analyses, a significant issue with phthalate ester contamination did not result from the use of this HDPE container.

If RCT-performed field screening of the LDUA shielded housing, or shielding used with the simple sampler or other applicable sampling device, indicates that the radioactivity of the sample precludes performing sample apportioning in the field, the samples will be transported to the RAL by field personnel. The RAL analyst will transfer sufficient liquid for the determination of VOCs to one 40-ml glass vial for the determination of methanol by EPA method 8015B analysis and two separate 40-ml glass vials for the determination of the other required VOCs by EPA method 8260B and acidify the samples (as defined in Chapter 2 of SW-846 and listed in Table 17). If the samples are to be transported to another laboratory for analysis, the samples will be placed in a shipping container and cooled to 4°C using ice or blue ice. The RAL technical staff shall inspect the individual sample matrices generated during the phase separation process to determine if each sample phase contains sufficient material to perform the requested analysis. Samples determined to contain insufficient material to perform the requested analysis must be composited with materials of the same matrix from other samples collected from the same location. The need for additional samples will be determined by the laboratory and the PM. The individual matrices must be placed in the appropriate analysis-specific glass or HDPE containers and preserved as described in Tables 16 and 17 prior to transport to the analytical laboratory performing the analyses.

If the radiation fields of the samples allow manipulation of the sampled media in the field, the sampling personnel will segregate (as best as possible) liquid and solid material into samples collected in the appropriate sample containers. It is important to collect sufficient amounts of sample to allow the requested analyses to be performed. Insufficient sample amounts could affect detection limits achieved at the laboratory and, therefore, the ability to make decisions using the data. The appropriate containers are specified in Tables 16 and 17. If it is possible to aliquot samples into the appropriate sample bottles in the field, but not possible to safely separate liquid from solid sample material, the materials from the tanks will be separated into solid and liquid phases by trained laboratory personnel and segregated into appropriate containers upon receipt at the laboratory and before analysis.

5.1.6 Sample Transport

Upon completion of sample retrieval from the WM-182 and WM-183 tank heels, vault sumps, and DVB-C6 sump, appropriate precautions will be used, to seal the sample collection container that houses the liquid and solid phases of material. The sealed container will then be approached and, if within safety limits, scanned by a RCT using hand-held radiation survey equipment. If the activity of the container is

too high to allow the RCT to approach it, the container will be placed inside a shielded secondary transport vessel, which will be sealed. The sample and the containment vessel will be transported to a vehicle using a handcart equipped with a lock-down strap. Upon completion of sample retrieval from the WM-182 and WM-183 tank heels, vault sumps and the DVB-C6 sump, the LDUA system or simple sampler operations personnel will place the sample chamber into the transport cart. The cart will then be transported to RAL for turnover to RAL personnel.

If the activity of the material retrieved from the tank, vault sump, or DVB-C6 sump allows field apportionment of the sampled material, the HDPE container will be placed in a staging area where sample apportioning can be conducted. For samples of tank heels, vault sump, and DVB-C6 sump contents apportioned in the field and for all samples collected from the cooling coils, after the appropriate aliquots have been collected in the pre-labeled bottles of the sizes defined in Tables 16 and 17, the samples will be placed in a shipping cooler containing sufficient blue ice such that the temperature of the container can be maintained at approximately 4°C ± 2°C. The completed COC form, prepared during sample apportionment, will be taped inside the cooler to document transfer of custody of the samples by the sampling team member or FTL. Custody seals will be taped to the shipping cooler to ensure the integrity of the COC between the INEEL and the analytical laboratory.

If the samples from the tank heels, vault sumps, and/or DVB-C6 sump must be transported to the RAL for sample apportionment, field and trip blanks will not be introduced prior to transport of the sample to the RAL. The field and trip blanks would have little use because they will be handled differently than the sample. As the field and trip blanks would not enter the transport vessel or the hot cell, the analysis of these blanks would not represent contamination introduced during transport of these samples. If aliquots of the samples are to be shipped for off-site VOC analyses, trip blanks will be introduced in sample shipping containers prior to shipment.

If sample aliquots for samples collected from the tanks are prepared in a staging area in the field, field and trip blanks will be introduced at that point of the process. These blanks will also be introduced during collection of samples from the cooling coils (field blanks only) where radiation concerns are not anticipated to affect collection of samples directly into appropriate containers. Trip blanks are organic-free water in a 40-ml vial, sent from the laboratory that will be performing the analyses, that accompanies VOC water samples during the sample collection and shipment processes. An alternative source of trip blank water is from the INEEL Analytical Laboratories Department where reagent water that has been heated and pre-purged with an inert gas is available for use as trip blank media. Trip blanks evaluate cross-contamination during sample handling, shipment, and storage. Field blanks are analyte-free water, which is poured into a sample container at the sample collection site to check cross-contamination during sample collection and shipment. Field blanks are often not collected during waste sampling activities because the very low level of cross contamination detectable using field blanks would not affect a decision concerning data obtained from measurements on a concentrated waste. In the case of this sampling, as the material being sampled is the decontamination rinsate solution and potentially some residual solids, data concerning cross-contamination may be useful for data interpretation. This is especially true since the scenario under which field blank samples will be used is one where significant field manipulation of the sampled material has occurred.

5.1.7 Waste Management

Wastes generated as a result of the post-decontamination characterization of the WM-182 and WM-183 tank system components will include laboratory wastes and waste generated from decontamination of the simple sampler sample chamber, and/or LDUA. Field wastes in the form of paper towels and other wastes associated with the sample apportionment activities will be generated as a result of sample collection. The INEEL WGS group will ensure that disposition of non-sample waste material is

in compliance with the HWMA/RCRA Closure Plan and that applicable paperwork is completed. All samples and analysis wastes disposed by the INEEL Analytical Chemistry Laboratory will be disposed to the PEW evaporator system through normal routes or in accordance with INEEL MCP-2864, "Sample Management" (INEEL 1999a). The WGS WTS will ensure compliance with the applicable HWMA/RCRA requirements and PRD-166, "PEW Chemical Acceptance Criteria" (INEEL 1999b).

6. SAMPLING PROCEDURES

The potential to encounter high radiation fields in the tanks preclude the use of standard sample collection techniques. An LDUA has been used for inspecting tank interiors and collecting samples of the tank contents. The LDUA will be used to perform a variety of functions including video inspection of the tank contents and may be used for collection of liquid and solid samples from the post-decontamination tank heels, the vault sumps, and the DVB-C6 sump. Samples of rinse solutions from the cooling coils will be collected using existing sample collection ports installed in CPP-628. Other possible sampling approaches include:

- Collection of decontamination rinsate or heel samples at the discharge of the steam jets pump used for heel reduction

- Collection of liquid samples through risers with bailers or other grab sampling techniques.

If an alternative sampling approach is chosen, the specific procedures relevant to the chosen approach will be incorporated in a revision to this SAP. This document assumes the use of the simple sampler, LDUA, or other remote sampling equipment to collect samples from the tanks at the location specified in Section 5.1.2, vault sumps, and DVB-C6 sump. The use of existing sample-collection systems for the cooling coils will be used, and the sampling procedures of the waste transfer lines is covered in the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the Process Waste Lines from INTEC Tank Farm Facility Tanks WM-182 and WM-183* (INEEL 2001a).

6.1 Simple Sampler

The simple sampler consists of a sample collection chamber attached to a line that can be lowered into tank risers. The sample collection chamber is narrow enough that it can fit through the 2-in. pipe that is part of three riser assemblies. The lines that lower the sampler to the floor of the tank can be used to apply a vacuum using a bimba tube to the chamber, allowing tank contents to enter the sampler nose and fill the chamber. Cold tests of the simple sampler showed it could collect solids and liquids in very close proportion to the known amounts of each of these phases in the test solutions.

The sample chamber capacity is roughly 250 ml. The sample chamber will be filled to the maximum extent possible during each simple sampler trip. The sample chamber will be surveyed by an RCT to determine if samples collected meet acceptance criteria for contact-handled apportioning in the staging area or if the sample must be transported to the RAL for this activity. This survey will also be conducted to ensure that exposure for sampling team members and decontamination personnel are maintained ALARA.

6.2 Light-Duty Utility Arm

The LDUA consists of a robotic arm controlled by computer interface and a sampler EE that attaches to the LDUA through a tool interface plate. The EE uses negative pressure to pull sample material into a chamber located along the arm and above the tank contents. The LDUA, equipped with the EE and sample chamber, will be used to collect volumetric samples for liquids overlaying residual solids in the tank heel and to collect solid liquid mixtures collected from the bottom of the tank heel at the liquid-solid interface.

6.2.1 Sample Chamber

The sample chamber of the EE is an irregularly shaped box, containing a sight window to verify the presence of a sample, and two septa ports on the side to allow sample or gas removal from the sealed compartment. The valve box on top of the sample chamber contains a valve that will be manipulated to obtain the sample. The sample chamber has a 1,200 ml capacity; however, each sample is anticipated to be closer to 200 ml because of the sample matrix. The sample chamber will be filled to the maximum extent possible during each LDUA trip. The sample chamber and valve box are attached to the main EE housing with a quick-release mechanism to allow the sample to be remotely released from the housing for transport to the RAL. The sample chamber will be surveyed by an RCT to determine if samples collected meet acceptance criteria for contact-handled apportioning in the staging area or if the sample must be transported to the RAL for this activity. This survey will also be conducted to ensure that exposure for sampling team members and decontamination personnel are maintained ALARA. The entire LDUA and sample chamber is controlled via a computer, which is located in a shielded, remote location.

6.2.2 Sample Chamber Decontamination

To ensure the integrity of samples collected from the five separate sampling locations, the LDUA and the EE must be decontaminated between sampling locations. To accomplish this, the LDUA's interior surfaces that contact the post-decontamination rinsate during sample collection will be rinsed using demineralized water delivered from the arm through three nozzles. Two nozzles are mounted within the capture tube to rinse the interior, and one nozzle is mounted to the sample tube to flush it and the sample chamber clean. Sufficient volumes of demineralized water, and sufficient numbers of rinses, will be used to decontaminate the entire chamber and arm apparatus.

6.3 Sample Collection Procedures

To ensure that all samples are collected in a comparable way from sampling effort to sampling effort, direction is provided in the following sections. Specific SOPs for sample collection are outlined, sample handling SOPs are provided, and all specific sample preparation and analysis guidance is provided.

Procedures for operating the simple sampler will be documented prior to sample collection.

The following operating procedures are used to deploy and sample with the LDUA:

- CPP-TPR-P7.5-C1, "LDUA – Setup and Startup," will be used to prepare the LDUA system for deployment (INEEL 1999c)

- CPP-TPR-P7.5-D1, "LDUA – Normal Operations and Shutdown," provides instructions for connecting the sampler EE to the LDUA, operating the EE, obtaining the sample, transporting the sample to the RAL, shutting the LDUA and its support systems down, and other supporting activities (INEEL 1998)

- *Deployment Plan for the LDUA Modified Heel Sampling End Effector*, contains additional information and guidance for the deployment activities. (INEEL 2001b)

The radiological controls and personnel-monitoring requirements established for LDUA operations and the subsequent sample transfer are based on calculated radiation exposure rates. The calculated exposure rates were based on historical tank sample-analysis records. As a result, the operating procedures and associated radiological work permit tasks issued for the work will implement and/or

specify action levels to ensure all work activities and personnel exposure to direct radiation are maintained ALARA. Any decision to remotely disconnect the sampler from the sampler EE using the auxiliary robot arm and to remotely load the transfer container for transport to the RAL facility will be based on a series of data points obtained just before, during, and after simple sampler or LDUA deployment. The decision to resample will not be made without authorization from the appropriate responsible facility, operational, and program personnel located at the job site.

If the simple sampler is used, radiation measurements will be taken after the simple sampler is retrieved from the riser using instruments under control of the INTEC RCTs. If the LDUA is used to collect samples, direct radiation measurements will be taken at the following times and locations as conditions permit:

- Prior to deployment, over the open riser top using the sampler EE Geiger Mueller tube (approximating 12-in. horizontal distance)
- At various elevations as the sampler is lowered into the tank
- After the LDUA maximum descent distance has been set and just prior to actuating the EE sampling process
- Following the activation of the EE sampler and just prior to starting retrieval movement of the LDUA
- Approximately 12-in. after the open riser top horizontal plane has been broken
- After the sample chamber has been moved to a location where the decision on field or laboratory apportionment of the sample will be made.

The direct radiation readings shall be recorded in the field logbook and saved with the sampling and analysis results.

Two support mechanisms will be in place to verify that the direct radiation readings from the loaded EE sampler are within the calculated dose rates: strategically placed telemetry dosimeters with remote readout capability and a direct radiation survey. With approval from the FTL, an RCT will approach the containment using appropriate hand-held instrumentation. The final decision to transport the sample to RAL will take into account the direct radiation measurements and the specific sample-handling requirements for samples in the field in the sample apportionment staging area. If the sample cannot be handled in the field sample apportionment staging area, the sample will be loaded for transport to the RAL facility.

Field manipulation of the sample will be based on the total activity of the sampled liquid as defined in the HLW Safety Analysis Report (SAR) (INEEL 1999d). The RCT's evaluation of the sample's radiation levels ensures the sample will comply with the SAR and the radiological protection manual (INEEL 2000a) requirements.

Once some material has been collected in the sample chamber, collection of additional sample volume in the same container is discouraged. Further attempts could cause damage to, or contamination of, the vacuum pump. If more volume is needed than can be obtained in one sample attempt, the retrieved sample volume will be transported to the sample apportionment staging area or the RAL and another trip will be made to obtain more sample material. Additional sample volume can be obtained with another

clean sample chamber or by reusing the original sample chamber after it has been drained, cleaned, and rinsed in the sample apportionment staging area or in the RAL.

Samples of rinsate collected from representative sections of the cooling coils will be directly filled in the appropriate bottles. The samples from the cooling coils will be collected from the sample collection valves in CPP-628. Sixty cooling coil lines are part of each tank system. The major contaminant of these lines is chromium, which was used as a corrosion inhibitor. Of these 120 lines (60 in each tank), 10 (5 samples from each tank) will be sampled for chromium analysis by inductively coupled plasma (ICP) method SW-846 6010B.

The DVB-C6 will be rinsed to decontaminate the interior surfaces. The rinsate solution will drain to the DVB-C6 sump and a sample from inside the valve box sump will be collected. The valve boxes (DVB-A5 and –A6) will be decontaminated and allowed to drain to the associated vault sump. The vault floor will then be decontaminated, and a final rinsate that represents the composite of the valve box and vault floor rinsates will be collected from the vault sump. All samples collected from the vault sump and DVB-C6 will be analyzed for total metals, VOCs, SVOCs, PCBs, methanol, pyridine, ethyl acetate, N-nitrosodimethylamine, cyclohexanone, radionuclides, and anions by the methods specified in Table 15.

Table 18 provides a summation of the samples that are anticipated to be collected during the sampling efforts and includes the number of anticipated samples, anticipated collection dates, and the analytes anticipated to be requested for each sample. If the samples must be transported to the RAL for sample apportionment, field and trip blanks will not be collected as stated in Section 5.1.6, “Sample Transport.” If tank, vault sump, and/or DVB-C6 sample aliquots are prepared in a staging area in the field, and for samples collected from the cooling coils, field and trip blanks will be introduced at the sample collection point as discussed in Section 5.1.6, “Sample Transport.”

Table 18. Anticipated sample collection from each of the WM-182 and WM-183 tank systems.

Analysis	Estimated Number of Samples from Each Tank[a]	Vault Sump/ DVB-C6[b]	Cooling Coils	Matrix[c]	Analytes of Interest	Dates of Collection
Anions	5	5		Liquid	Cl, F, PO_4, NO_3, SO_4	TBD
Methanol	5	5		Liquid	EPA methods 8015B using a direct injection technique for methanol	TBD
PCBs	5	5		Solid	EPA method 8082	TBD
PCBs	5	5		Liquid	EPA method 8082	TBD
pH	5	5	5	Liquid	pH	TBD
Radionuclides	5	5	5 (γ only)	Liquid	^{241}Am, ^{14}C, ^{60}Co, $^{134, 137}$Cs, ^{3}H, ^{129}I, ^{237}Np, ^{63}Ni, ^{90}Sr, ^{99}Tc, ^{94}Nb, $^{155, 154}$Eu, ^{244}Cm $^{238, 239/240, 241}$Pu, $^{234, 235, 236, 238}$U	TBD
Radionuclides[d]	5	5		Solid	^{241}Am, ^{14}C, ^{60}Co, $^{134, 137}$Cs, ^{3}H, ^{129}I, ^{237}Np, ^{63}Ni, ^{90}Sr, ^{99}Tc, ^{94}Nb, $^{155, 154}$Eu, ^{244}Cm $^{238, 239/240, 241}$Pu, $^{234, 235, 236, 238}$U	TBD
Semi-Volatile Organic Compounds (SVOCs)	5	5		Solid	EPA method 8270C	TBD
Semi-Volatile Organics	5	5		Liquid	EPA method 8270C	TBD
Total Metals	5	5	5	Liquid Solid	Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Mo, Na, Ni, Pb, Sb, Se, Tl, V, Zn	TBD
Toxicity Characteristic Leaching Procedure Metals	5			Solid	Ag, As, Ba, Cd, Cr, Hg, Pb, and Se	TBD
Volatile Organic Compounds (VOCs)	5	5		Solid	EPA method 8260B	TBD
Volatile Organics	5	5		Liquid	EPA method 8260B	TBD

a. The number of samples does not include trip blanks and field blanks; trip and field blanks will be collected at the following frequencies: Trip blanks – collected for VOC analyses only, 1 for each cooler shipped with VOC samples in them; Field blanks – 1 each day of sample collection for each type of analysis collected if sample apportionment occurs in the field.

b. One sample collected from each of the two sumps per tank (thus, two in WM-182 and two in WM-183) following final rinse for all valve boxes that flow into the vault sump and the vault floor and one additional sample from the DVB-C6 sump.

c. Solid material will only be analyzed if present at greater than 15% the total sample volume retrieved.

d. This includes the radionuclides that will contribute the greatest dose from the list of key radionuclides as described in DOE Manual 435.1-1 Chapter II (DOE 2001b).

7. ANALYTICAL METHODS

To ensure that data of acceptable quality is obtained from the post-decontamination characterization of the WM-182 and WM-183 tank system components, standard EPA laboratory methods or technically appropriate methods for radioanalytical determinations will be used to obtain project laboratory data. Analytical measurements and the reporting protocols that will be used to determine inorganic, organic, and radiochemical constituents are outlined in Table 19.

Table 19. Analytical method source documents and method descriptions.

Inorganic and Organic Determination Method[a]	Description
1311	Toxicity characteristic leaching procedure (TCLP)
3010A	Acid digestion of aqueous samples and extracts for total metals for analysis by FLAA or ICP spectroscopy
3050B	Acid digestion of sediments, sludges, and soils
6010B	Inductively Coupled Plasma-Atomic Emission Spectroscopy
7470A/7471	Determination of mercury in waste using the cold vapor atomic absorption spectroscopy
8015B[b]	Nonhalogenated organics using GC/ flame ionization detector (FID)
8082	Polychlorinated Biphenyls by Gas Chromatography
8260B	Volatile organic analysis by gas chromatography/mass spectrometer
8270C	SVOA by gas chromatography/mass spectrometer
9040B	pH Electrometric Measurement
9056	Determination of Inorganic Anions by Ion Chromatography
Radiochemical Determinations	
ER-SOW-163	Determination of radionuclides

a. EPA (1996).

b. The laboratory will perform method 5031 prior to the analysis of samples using method 8015B.

c. INEEL Sample Management Office SOW for Radionuclide Analyses ER-SOW-163.

TCLP metals sample preparation and analysis of solids retrieved from the tanks will be performed on the WM-182 and WM-183 samples using the methods listed in Table 19. The TCLP method specifies that samples with less than 0.5% solids do not require extraction. If less than 15% of the total sample mass retrieved is solid material, no hazardous constituent analyses will be conducted on solid samples. Radionuclide analyses will be required for all solids and liquids (except from the cooling coils) collected. TCLP typically requires a 100 g sample. Idaho DEQ has authorized the INEEL to allow laboratories to use smaller amounts as a sample when ALARA concerns exist. The laboratory SOW will specify that if smaller sample mass will be used, project management must be contacted to authorize this action. Project personnel will consult with persons cognizant of laboratory methods to ensure the impacts to method limits detection (MDLs) caused by using a smaller sample volume will not adversely impact the data use relative to the project DQOs.

Determinations for total inorganic and organic constituents will be performed by the methods presented in *Test Methods for the Evaluation of Solid Waste, Physical Chemical Methods* (EPA 1996) and listed in Table 19. Radiological determinations will be performed according to approved methods and ER-SOW-163 requirements.

Tables 20 and 21 provide a summary of method-specific requirements that will be followed by the analytical laboratory to the extent possible given the sample restrictions. Any deviations from this information will be fully documented, and the PQAO and/or the PM will be informed of deviations.

Table 20. Sample preparation, analytical methods, and recommended detection limits—solids.

Analysis	Recommended Detection Limit in mg/kg except TCLP metals in mg/L (pCi/g for Radionuclides)	Preparation Method	Analysis Method
TCLP Extraction	Not Applicable	SW-846 1311	Not Applicable
TCLP Metals Analysis			
Arsenic	40	SW-846 3010A	SW-846 6010B
Barium	40	SW-846 3010A	SW-846 6010B
Cadmium	1	SW-846 3010A	SW-846 6010B
Chromium	2	SW-846 3010A	SW-846 6010B
Lead	0.6	SW-846 3010A	SW-846 6010B
Mercury	0.04	SW-846 7470A	SW-846 7471A
Selenium	1	SW-846 3010A	SW-846 6010B
Silver	2	SW-846 3010A	SW-846 6010B
Total Metals			
Aluminum	60	SW-846 3050B	SW-846 6010B
Antimony	40	SW-846 3050B	SW-846 6010B
Arsenic	2	SW-846 3050B	SW-846 7060A
Barium	2	SW-846 3050B	SW-846 6010B
Beryllium	0.4	SW-846 3050B	SW-846 6010B
Cadmium	0.4	SW-846 3050B	SW-846 6010B
Calcium	1.4	SW-846 3050B	SW-846 6010B
Chromium	1	SW-846 3050B	SW-846 6010B
Cobalt	1	SW-846 3050B	SW-846 6010B
Copper	0.8	SW-846 3050B	SW-846 6010B
Iron	8	SW-846 3050B	SW-846 6010B
Lead	56	SW-846 3050B	SW-846 6010B
Manganese	1.8	SW-846 3050B	SW-846 6010B
Mercury	0.04	SW-846 7471A	SW-846 7471A
Nickel	20	SW-846 3050B	SW-846 6010B
Selenium	34	SW-846 3050B	SW-846 7740
Silver	10	SW-846 3050B	SW-846 6010B
Thallium	60	SW-846 3050B	SW-846 6010B
Vanadium	10	SW-846 3050B	SW-846 6010B
Zinc	2	SW-846 3050B	SW-846 6010B
Radionuclides			
^{241}Am	0.2	ER-SOW-163	ER-SOW-163
^{14}C	3	ER-SOW-163	ER-SOW-163
^{244}Cm	0.05	ER-SOW-163	ER-SOW-163
^{3}H	20	ER-SOW-163	ER-SOW-163
^{129}I	1	ER-SOW-163	ER-SOW-163
^{63}Ni	5	ER-SOW-163	ER-SOW-163
^{237}Np	0.05	ER-SOW-163	ER-SOW-163
$^{238, 239/240}Pu$	0.05	ER-SOW-163	ER-SOW-163

Table 20. (continued).

Analysis	Recommended Detection Limit in mg/kg except TCLP metals in mg/L (pCi/g for Radionuclides)	Preparation Method	Analysis Method
^{241}Pu	1	ER-SOW-163	ER-SOW-163
^{90}Sr	0.5	ER-SOW-163	ER-SOW-163
^{99}Tc	1	ER-SOW-163	ER-SOW-163
U isotopic	0.05	ER-SOW-163	ER-SOW-163
Gamma-emitting radionuclides: ^{60}Co, $^{134, 137}$Cs, ^{94}Nb, $^{154, 155}$Eu	0.1[a]	ER-SOW-163	ER-SOW-163
Organic Constituents			
Volatiles[b]			
2-Butanone	2	SW-846 5035	SW-846 8260B
1,1-Dichloroethene	2	SW-846 5035	SW-846 8260B
1,2-Dibromoethane	2	SW-846 5035	SW-846 8260B
1,2-Dibromo-3-chloropropane	2	SW-846 5035	SW-846 8260B
1,2-Dichlorobenzene	2	SW-846 5035	SW-846 8260B
1,3-Dichlorobenzene	2	SW-846 5035	SW-846 8260B
1,4-Dichlorobenzene	2	SW-846 5035	SW-846 8260B
1,2-Dichloropropane	2	SW-846 5035	SW-846 8260B
2-Hexanone	2	SW-846 5035	SW-846 8260B
4-Methyl-2-pentanone	2	SW-846 5035	SW-846 8260B
1,1,2,2-Tetrachloroethane	2	SW-846 5035	SW-846 8260B
1,2,4-Triclorobenzene	2	SW-846 5035	SW-846 8260B
1,1,1-Trichloroethane	2	SW-846 5035	SW-846 8260B
1,1,2-Trichloroethane	2	SW-846 5035	SW-846 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	2	SW-846 5035	SW-846 8260B
Acetone	2	SW-846 5035	SW-846 8260B
Benzene	2	SW-846 5035	SW-846 8260B
Bromodichloromethane	2	SW-846 5035	SW-846 8260B
Bromoform	2	SW-846 5035	SW-846 8260B
Bromomethane	2	SW-846 5035	SW-846 8260B
Carbon Disulfide	2	SW-846 5035	SW-846 8260B
Carbon Tetrachloride	2	SW-846 5035	SW-846 8260B
Chlorobenzene	2	SW-846 5035	SW-846 8260B
Chloroethane	2	SW-846 5035	SW-846 8260B
Chloroform	2	SW-846 5035	SW-846 8260B
Chloromethane	2	SW-846 5035	SW-846 8260B
cis-1,2-Dichloroethene	2	SW-846 5035	SW-846 8260B
cis-1,3-Dichloropropene	2	SW-846 5035	SW-846 8260B
Cyclohexane	2	SW-846 5035	SW-846 8260B
Cyclohexanone	1.4	SW-846 5035	SW-846 8260B
Dibromochloromethane	2	SW-846 5035	SW-846 8260B
Dichlorodifluoromethane	2	SW-846 5035	SW-846 8260B
Ethyl acetate	5	SW-846 5035	SW-846 8260B

Table 20. (continued).

Analysis	Recommended Detection Limit in mg/kg except TCLP metals in mg/L (pCi/g for Radionuclides)	Preparation Method	Analysis Method
Ethylbenzene	2	SW-846 5035	SW-846 8260B
Isopropylbenzene	2	SW-846 5035	SW-846 8260B
Methanol	5	SW-846 8015B	SW-846 8015B
Methyl Acetate	2	SW-846 5035	SW-846 8260B
Methylcyclohexane	2	SW-846 5035	SW-846 8260B
Methylene Chloride	2	SW-846 5035	SW-846 8260B
Styrene	2	SW-846 5035	SW-846 8260B
Tetrachloroethene	2	SW-846 5035	SW-846 8260B
Toluene	2	SW-846 5035	SW-846 8260B
Trans-1,2-Dichloroethene	2	SW-846 5035	SW-846 8260B
Trans-1,3-Dichloropropene	2	SW-846 5035	SW-846 8260B
Trichloroethene	2	SW-846 5035	SW-846 8260B
Trichlorofluoromethane	2	SW-846 5035	SW-846 8260B
Vinyl Chloride	2	SW-846 5035	SW-846 8260B
Xylenes (Total)	2	SW-846 5035	SW-846 8260B
Semivolatiles			
1,1'-Biphenyl	2	SW-846 3540C	SW-846 8270C
4-Bromophenyl-phenylether	2	SW-846 3540C	SW-846 8270C
4-Chloroaniline	2	SW-846 3540C	SW-846 8270C
2-Chloronaphthalene	2	SW-846 3540C	SW-846 8270C
2-Chlorophenol	2	SW-846 3540C	SW-846 8270C
4-Chlorophenyl-phenylether	2	SW-846 3540C	SW-846 8270C
4-Chloro-3-methylphenol	2	SW-846 3540C	SW-846 8270C
3,3'-Dichlorobenzidine	2	SW-846 3540C	SW-846 8270C
2,4-Dichlorophenol	2	SW-846 3540C	SW-846 8270C
2,4-Dimethylphenol	2	SW-846 3540C	SW-846 8270C
2,4-Dinitrophenol	5	SW-846 3540C	SW-846 8270C
2,4-Dinitrotoluene	2	SW-846 3540C	SW-846 8270C
2,6-Dinitrotoluene	2	SW-846 3540C	SW-846 8270C
4,6-Dinitro-2-methylphenol	5	SW-846 3540C	SW-846 8270C
2-Methylnaphthalene	2	SW-846 3540C	SW-846 8270C
2-Methylphenol	2	SW-846 3540C	SW-846 8270C
4-Methylphenol	2	SW-846 3540C	SW-846 8270C
2-Nitroaniline	5	SW-846 3540C	SW-846 8270C
3-Nitroaniline	5	SW-846 3540C	SW-846 8270C
4-Nitroaniline	5	SW-846 3540C	SW-846 8270C
2-Nitrophenol	2	SW-846 3540C	SW-846 8270C
4-Nitrophenol	5	SW-846 3540C	SW-846 8270C
2,2'-Oxybis (1-Chloropropane)	2	SW-846 3540C	SW-846 8270C
2,4,5-Trichlorophenol	5	SW-846 3540C	SW-846 8270C
2,4,6-Trichlorophenol	2	SW-846 3540C	SW-846 8270C

Table 20. (continued).

Analysis	Recommended Detection Limit in mg/kg except TCLP metals in mg/L (pCi/g for Radionuclides)	Preparation Method	Analysis Method
Acenaphthene	2	SW-846 3540C	SW-846 8270C
Acenaphthylene	2	SW-846 3540C	SW-846 8270C
Acetophenone	2	SW-846 3540C	SW-846 8270C
Anthracene	2	SW-846 3540C	SW-846 8270C
Atrazine	2	SW-846 3540C	SW-846 8270C
Benzaldehyde	2	SW-846 3540C	SW-846 8270C
Benzo(a)anthracene	2	SW-846 3540C	SW-846 8270C
Benzo(a)pyrene	2	SW-846 3540C	SW-846 8270C
Benzo(b)fluoranthene	2	SW-846 3540C	SW-846 8270C
Benzo(g,h,i)perylene	2	SW-846 3540C	SW-846 8270C
Benzo(k)fluoranthene	2	SW-846 3540C	SW-846 8270C
bis-(2-Chloroethoxy) methane	2	SW-846 3540C	SW-846 8270C
bis-(2-Chloroethyl)ether	2	SW-846 3540C	SW-846 8270C
bis-(2-Ethylhexyl)phthalate	2	SW-846 3540C	SW-846 8270C
Butylbenzylphthalate	2	SW-846 3540C	SW-846 8270C
Caprolactam	2	SW-846 3540C	SW-846 8270C
Carbazole	2	SW-846 3540C	SW-846 8270C
Chrysene	2	SW-846 3540C	SW-846 8270C
Dibenz(a,h)anthracene	2	SW-846 3540C	SW-846 8270C
Dibenzofuran	2	SW-846 3540C	SW-846 8270C
Diethylphthalate	2	SW-846 3540C	SW-846 8270C
Dimethylphthalate	2	SW-846 3540C	SW-846 8270C
Di-n-butylphthalate	2	SW-846 3540C	SW-846 8270C
Di-n-octylphthalate	2	SW-846 3540C	SW-846 8270C
Fluoranthene	2	SW-846 3540C	SW-846 8270C
Fluorene	2	SW-846 3540C	SW-846 8270C
Hexachlorobenzene	2	SW-846 3540C	SW-846 8270C
Hexachlorobutadiene	2	SW-846 3540C	SW-846 8270C
Hexachlorocyclopentadiene	2	SW-846 3540C	SW-846 8270C
Hexachloroethane	2	SW-846 3540C	SW-846 8270C
Indeno(1,2,3-cd)pyrene	2	SW-846 3540C	SW-846 8270C
Isophorone	2	SW-846 3540C	SW-846 8270C
Naphthalene	2	SW-846 3540C	SW-846 8270C
Nitrobenzene	2	SW-846 3540C	SW-846 8270C
N-Nitrosodimethylamine	0.03	SW-846 3540C	SW-846 8270C
N-Nitroso-di-n-propylamine	2	SW-846 3540C	SW-846 8270C
N-Nitrosodiphenylamine	2	SW-846 3540C	SW-846 8270C
Pentachlorophenol	5	SW-846 3540C	SW-846 8270C
Phenanthrene	2	SW-846 3540C	SW-846 8270C
Phenol	2	SW-846 3540C	SW-846 8270C
Pyrene	2	SW-846 3540C	SW-846 8270C

Table 20. (continued).

Analysis	Recommended Detection Limit in mg/kg except TCLP metals in mg/L (pCi/g for Radionuclides)	Preparation Method	Analysis Method
Pyridine	4	SW-846 3540C	SW-846 8270C
Tri-n-butylphosphate	5	SW-846 3540C	SW-846 8270C
AROCLORS (PCBs)			
Aroclor-1016	0.4	SW-846 3540C	SW-846 8082
Aroclor-1221	0.2	SW-846 3540C	SW-846 8082
Aroclor-1232	0.2	SW-846 3540C	SW-846 8082
Aroclor-1242	0.2	SW-846 3540C	SW-846 8082
Aroclor-1248	0.2	SW-846 3540C	SW-846 8082
Aroclor-1254	0.2	SW-846 3540C	SW-846 8082
Aroclor-1260	0.2	SW-846 3540C	SW-846 8082

a. Based on ^{137}Cs, all other gamma isotopes shall have a detection limit commensurate with their photon yield and energy as related to the ^{137}Cs detection limit.

b. The estimated quantitation limit (EQL) is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. However, it may be nominally chosen within these guidelines to simplify data reporting. For many analytes the EQL analyte concentration is selected for the lowest non-zero standard in the calibration curve. Sample EQLs are highly matrix-dependent. The EQLs listed herein are provided as an example from EPA-SW-846 (EPA 1996) and may not always be achievable.

Table 21. Sample preparation, analytical methods, and recommended detection limits—liquids.

Analysis	Recommended Detection Limit in mg/L[a] (pCi/L for Radionuclides)	Preparation Method	Analysis Method
Anions			
Chloride	0.2	SW-846 9056	SW-846 9056
Fluoride	0.05	SW-846 9056	SW-846 9056
Nitrate	0.02	SW-846 9056	SW-846 9056
Phosphate	0.03	SW-846 9056	SW-846 9056
Sulfate	0.2	SW-846 9056	SW-846 9056
Total Metals			
Aluminum	0.3	SW-846 3010A	SW-846 6010B
Antimony	0.2	SW-846 3010A	SW-846 6010B
Arsenic	0.01	SW-846 3010A	SW-846 6010B
Barium	0.01	SW-846 3010A	SW-846 6010B
Beryllium	0.002	SW-846 3010A	SW-846 6010B
Cadmium	0.02	SW-846 3010A	SW-846 6010B
Calcium	0.07	SW-846 3010A	SW-846 6010B
Chromium	0.05	SW-846 3010A	SW-846 6010B
Cobalt	0.05	SW-846 3010A	SW-846 6010B
Copper	0.04	SW-846 3010A	SW-846 6010B
Iron	0.04	SW-846 3010A	SW-846 6010B
Lead	0.3	SW-846 3010A	SW-846 6010B
Manganese	0.01	SW-846 3010A	SW-846 6010B
Mercury	0.002	SW 846 7470A	SW-846 7470A
Nickel	0.1	SW-846 3010A	SW-846 6010B
Selenium	0.02	SW-846 3010A	SW-846 6010B
Silver	0.05	SW-846 3010A	SW-846 6010B
Thallium	0.3	SW-846 3010A	SW-846 6010B
Vanadium	0.05	SW-846 3010A	SW-846 6010B
Zinc	0.01	SW-846 3010A	SW-846 6010B
Radionuclides			
^{241}Am	0.2	ER-SOW-163	ER-SOW-163
^{14}C	3	ER-SOW-163	ER-SOW-163
^{244}Cm	0.2	ER-SOW-163	ER-SOW-163
^{3}H	400	ER-SOW-163	ER-SOW-163
^{129}I	1	ER-SOW-163	ER-SOW-163
^{63}Ni	5	ER-SOW-163	ER-SOW-163
^{237}Np	0.2	ER-SOW-163	ER-SOW-163
$^{238, 239/240}$Pu	0.2	ER-SOW-163	ER-SOW-163
^{241}Pu	10	ER-SOW-163	ER-SOW-163
^{90}Sr	1	ER-SOW-163	ER-SOW-163
^{99}Tc	10	ER-SOW-163	ER-SOW-163

Table 21. (continued).

Analysis	Recommended Detection Limit in mg/L[a] (pCi/L for Radionuclides)	Preparation Method	Analysis Method
U isotopic	0.5	ER-SOW-163	ER-SOW-163
Gamma-emitting Radionuclides: ^{60}Co, $^{134, 137}$Cs, ^{94}Nb, $^{154, 155}$Eu	30[b]	ER-SOW-163	ER-SOW-163
Organic Constituents			
Volatiles[c]			
2-Butanone	0.01	SW-846 5030B	SW-846 8260B
1,2-Dichlorobenzene	0.01	SW-846 5030B	SW-846 8260B
1,3-Dichlorobenzene	0.01	SW-846 5030B	SW-846 8260B
1,4-Dichlorobenzene	0.01	SW-846 5030B	SW-846 8260B
1,1-Dichloroethene	0.01	SW-846 5030B	SW-846 8260B
1,2-Dibromoethane	0.01	SW-846 5030B	SW-846 8260B
1,2-Dibromo-3-chloropropane	0.01	SW-846 5030B	SW-846 8260B
1,2-Dichloropropane	0.01	SW-846 5030B	SW-846 8260B
2-Hexanone	0.01	SW-846 5030B	SW-846 8260B
4-Methyl-2-pentanone	0.01	SW-846 5030B	SW-846 8260B
1,1,2,2-Tetrachloroethane	0.01	SW-846 5030B	SW-846 8260B
1,2,4-Triclorobenzene	0.01	SW-846 5030B	SW-846 8260B
1,1,1-Trichloroethane	0.01	SW-846 5030B	SW-846 8260B
1,1,2-Trichloroethane	0.01	SW-846 5030B	SW-846 8260B
1,1,2-Trichloro-1,2,2-Trifluoroethane	0.01	SW-846 5030B	SW-846 8260B
Acetone	0.01	SW-846 5030B	SW-846 8260B
Benzene	0.01	SW-846 5030B	SW-846 8260B
Bromodichloromethane	0.01	SW-846 5030B	SW-846 8260B
Bromoform	0.01	SW-846 5030B	SW-846 8260B
Bromomethane	0.01	SW-846 5030B	SW-846 8260B
Carbon Disulfide	0.01	SW-846 5030B	SW-846 8260B
Carbon Tetrachloride	0.01	SW-846 5030B	SW-846 8260B
Chlorobenzene	0.01	SW-846 5030B	SW-846 8260B
Chloroethane	0.01	SW-846 5030B	SW-846 8260B
Chloroform	0.01	SW-846 5030B	SW-846 8260B
Chloromethane	0.01	SW-846 5030B	SW-846 8260B
cis-1,2-Dichloroethene	0.01	SW-846 5030B	SW-846 8260B
cis-1,3-Dichloropropene	0.01	SW-846 5030B	SW-846 8260B
Cyclohexane	0.01	SW-846 5030B	SW-846 8260B
Cyclohexanone	0.007	SW-846 5030B	SW-846 8260B
Dibromochloromethane	0.01	SW-846 5030B	SW-846 8260B
Dichlorodifluoromethane	0.01	SW-846 5030B	SW-846 8260B
Ethyl acetate	0.025	SW-846 5030B	SW-846 8260B
Ethylbenzene	0.01	SW-846 5030B	SW-846 8260B
Isopropylbenzene	0.01	SW-846 5030B	SW-846 8260B
Methanol	0.025	SW-846 8015B	SW-846 8015B

Table 21. (continued).

Analysis	Recommended Detection Limit in mg/L[a] (pCi/L for Radionuclides)	Preparation Method	Analysis Method
Methyl Acetate	0.01	SW-846 5030B	SW-846 8260B
Methylcyclohexane	0.01	SW-846 5030B	SW-846 8260B
Methylene Chloride	0.01	SW-846 5030B	SW-846 8260B
Styrene	0.01	SW-846 5030B	SW-846 8260B
Tetrachloroethene	0.01	SW-846 5030B	SW-846 8260B
Toluene	0.01	SW-846 5030B	SW-846 8260B
Trans-1,2-Dichloroethene	0.01	SW-846 5030B	SW-846 8260B
Trans-1,3-Dichloropropene	0.01	SW-846 5030B	SW-846 8260B
Trichloroethene	0.01	SW-846 5030B	SW-846 8260B
Trichlorofluoromethane	0.01	SW-846 5030B	SW-846 8260B
Vinyl Chloride	0.01	SW-846 5030B	SW-846 8260B
Xylenes (Total)	0.01	SW-846 5030B	SW-846 8260B
Semivolatiles			
1,1'-Biphenyl	0.01	SW-846 3520C	SW-846 8270C
4-Bromophenyl-phenylether	0.01	SW-846 3520C	SW-846 8270C
4-Chloroaniline	0.01	SW-846 3520C	SW-846 8270C
4-Chlorophenyl-phenylether	0.01	SW-846 3520C	SW-846 8270C
4-Chloro-3-methylphenol	0.01	SW-846 3520C	SW-846 8270C
3,3'-Dichlorobenzidine	0.01	SW-846 3520C	SW-846 8270C
2,4-Dichlorophenol	0.01	SW-846 3520C	SW-846 8270C
2,4-Dimethylphenol	0.01	SW-846 3520C	SW-846 8270C
2,4-Dinitrophenol	0.025	SW-846 3520C	SW-846 8270C
2,4-Dinitrotoluene	0.01	SW-846 3520C	SW-846 8270C
2,6-Dinitrotoluene	0.01	SW-846 3520C	SW-846 8270C
4,6-Dinitro-2-methylphenol	0.025	SW-846 3520C	SW-846 8270C
2-Chloronaphthalene	0.01	SW-846 3520C	SW-846 8270C
2-Chlorophenol	0.01	SW-846 3520C	SW-846 8270C
2-Methylnaphthalene	0.01	SW-846 3520C	SW-846 8270C
2-Methylphenol	0.01	SW-846 3520C	SW-846 8270C
4-Methylphenol	0.01	SW-846 3520C	SW-846 8270C
2-Nitroaniline	0.025	SW-846 3520C	SW-846 8270C
3-Nitroaniline	0.025	SW-846 3520C	SW-846 8270C
4-Nitroaniline	0.025	SW-846 3520C	SW-846 8270C
2-Nitrophenol	0.01	SW-846 3520C	SW-846 8270C
4-Nitrophenol	0.025	SW-846 3520C	SW-846 8270C
2,2'-Oxybis (1-Chloropropane)	0.01	SW-846 3520C	SW-846 8270C
2,4,5-Trichlorophenol	0.025	SW-846 3520C	SW-846 8270C
2,4,6-Trichlorophenol	0.01	SW-846 3520C	SW-846 8270C
Acenaphthene	0.01	SW-846 3520C	SW-846 8270C
Acenaphthylene	0.01	SW-846 3520C	SW-846 8270C
Acetophenone	0.01	SW-846 3520C	SW-846 8270C
Anthracene	0.01	SW-846 3520C	SW-846 8270C

Table 21. (continued).

Analysis	Recommended Detection Limit in mg/L[a] (pCi/L for Radionuclides)	Preparation Method	Analysis Method
Atrazine	0.01	SW-846 3520C	SW-846 8270C
Benzaldehyde	0.01	SW-846 3520C	SW-846 8270C
Benzo(a)anthracene	0.01	SW-846 3520C	SW-846 8270C
Benzo(a)pyrene	0.01	SW-846 3520C	SW-846 8270C
Benzo(b)fluoranthene	0.01	SW-846 3520C	SW-846 8270C
Benzo(g,h,i)perylene	0.01	SW-846 3520C	SW-846 8270C
Benzo(k)fluoranthene	0.01	SW-846 3520C	SW-846 8270C
bis-(2-Chloroethoxy) methane	0.01	SW-846 3520C	SW-846 8270C
bis-(2-Chloroethyl)ether	0.01	SW-846 3520C	SW-846 8270C
bis-(2-Ethylhexyl)phthalate	0.01	SW-846 3520C	SW-846 8270C
Butylbenzylphthalate	0.01	SW-846 3520C	SW-846 8270C
Caprolactam	0.01	SW-846 3520C	SW-846 8270C
Carbazole	0.01	SW-846 3520C	SW-846 8270C
Chrysene	0.01	SW-846 3520C	SW-846 8270C
Dibenz(a,h)anthracene	0.01	SW-846 3520C	SW-846 8270C
Dibenzofuran	0.01	SW-846 3520C	SW-846 8270C
Diethylphthalate	0.01	SW-846 3520C	SW-846 8270C
Dimethylphthalate	0.01	SW-846 3520C	SW-846 8270C
Di-n-butylphthalate	0.01	SW-846 3520C	SW-846 8270C
Di-n-octylphthalate	0.01	SW-846 3520C	SW-846 8270C
Fluoranthene	0.01	SW-846 3520C	SW-846 8270C
Fluorene	0.01	SW-846 3520C	SW-846 8270C
Hexachlorobenzene	0.01	SW-846 3520C	SW-846 8270C
Hexachlorobutadiene	0.01	SW-846 3520C	SW-846 8270C
Hexachlorocyclopentadiene	0.01	SW-846 3520C	SW-846 8270C
Hexachloroethane	0.01	SW-846 3520C	SW-846 8270C
Indeno(1,2,3-cd)pyrene	0.01	SW-846 3520C	SW-846 8270C
Isophorone	0.01	SW-846 3520C	SW-846 8270C
Naphthalene	0.01	SW-846 3520C	SW-846 8270C
Nitrobenzene	0.01	SW-846 3520C	SW-846 8270C
N-Nitrosodimethylamine	0.00015	SW-846 3520C	SW-846 8070A
N-Nitroso-di-n-propylamine	0.01	SW-846 3520C	SW-846 8270C
N-Nitrosodiphenylamine	0.01	SW-846 3520C	SW-846 8270C
Pentachlorophenol	0.025	SW-846 3520C	SW-846 8270C
Phenanthrene	0.01	SW-846 3520C	SW-846 8270C
Phenol	0.01	SW-846 3520C	SW-846 8270C
Pyrene	0.01	SW-846 3520C	SW-846 8270C
Pyridine	0.02	SW-864 3520C	SW-846 8015B
Tri-n-butylphosphate	0.025	SW-846 3520C	SW-846 8270C
AROCLORS (PCBs) Water			
Aroclor-1016	0.001	SW-846 3520C	SW-846-8082
Aroclor-1221	0.002	SW-846 3520C	SW-846-8082

Table 21. (continued).

Analysis	Recommended Detection Limit in mg/L[a] (pCi/L for Radionuclides)	Preparation Method	Analysis Method
Aroclor-1232	0.001	SW-846 3520C	SW-846-8082
Aroclor-1242	0.001	SW-846 3520C	SW-846-8082
Aroclor-1248	0.001	SW-846 3520C	SW-846-8082
Aroclor-1254	0.001	SW-846 3520C	SW-846-8082
Aroclor-1260	0.001	SW-846 3520C	SW-846-8082

a. The method detection limits for metals analyses conducted on the aqueous post-decontamination residuals is estimated by multiplying published instrument detection limits by ten.

b. Based on ^{137}Cs, all other gamma isotopes shall have a detection limit commensurate with their photon yield and energy as related to the ^{137}Cs detection limit.

c. The estimated quantitation limit (EQL) is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the method detection limit. However, it may be nominally chosen within these guidelines to simplify data reporting. For many analytes the EQL analyte concentration is selected for the lowest non-zero standard in the calibration curve. Sample EQLs are highly matrix-dependent. The EQLs listed herein are provided as an example from EPA-SW-846 (EPA 1996) and may not always be achievable.

8. INSTRUMENT CALIBRATION PROCEDURES

To ensure that sampling and analysis activities obtain the most accurate and precise information possible, field equipment and laboratory instrumentation must be calibrated according to both manufacturer specifications and to the appropriate analytical method specifications.

8.1 Laboratory Instrument Calibration

Laboratory instrumentation will be calibrated in accordance with each of the specified analytical methods (Table 19). The laboratory QAP shall include requirements for calibrations when specifications are not listed in analytical methods. Calibrations that are typically not called out in analytical methods include ancillary laboratory equipment (e.g., analytical balances, pipettes, pH meters) and verification of reference standards used for calibration and standard preparation. Laboratory documentation will include calibration techniques and sequential calibration actions, performance tolerances provided by the specific analytical method, and calibration dates and frequency. In addition, records for all laboratory-prepared standards will be maintained and provided with each data deliverable. Instrument responses for gas chromatography/mass spectrometry (GC/MS), GC retention time window definitions, and documentation of calibration check precision for GC and GC/MS systems will be reported in each deliverable. Standard reference materials used to perform calibration checks associated with both inorganic target analytes and radiochemical parameters will be prepared using an independent source for the standard materials from that used for preparation of the calibration standards. The results of these calibration checks will be reported with each data deliverable.

All analytical methods prescribed in Table 19 have specifications for equipment checks and instrument calibrations. The laboratory will comply with all method-specific calibration requirements for all requested parameters. If a failure of instrument calibration or equipment is detected, the instrument will be re-calibrated, and all affected samples will be analyzed using an acceptable calibration.

8.2 Field Equipment Calibration/Set-Up

The FTL will work closely with the operations personnel in charge of the LDUA to ensure that it is operating as recommended by the manufacturer and/or according to the design specifications. The required pre-sampling inspections will evaluate the LDUA and sample chamber mechanisms to ensure that they are functioning properly before placement of the LDUA into the tanks. Corrective actions for the repair or maintenance of the LDUA will be immediate and will be confirmed by the PM before sample collection.

The RCT will be responsible for calibration of all radiological monitoring equipment and the placement and handling of all telemetry dosimeters. The IH will be responsible for the measurement and evaluation of dosimeter results. All field calibrations will be documented in a field instrument calibration/standardization logbook as described in MCP-231, “Logbooks for the ER and D&D&D Projects” (INEEL 2000c).

8.3 Preventative Maintenance Procedures and Frequency

Field equipment will be managed using a calibration program compliant with all INEEL procedures. All laboratory equipment will be maintained to a level such that each piece of equipment and each laboratory instrument can meet method-specific QA/QC tolerances. Maintenance will be performed under the supervision of qualified personnel on all laboratory instrumentation in accordance with the manufacturer’s specifications, laboratory QAP, and SOPs.

Preventive maintenance of field equipment will be conducted in accordance with appropriate facility SOPs. *EPA Requirements for Quality Assurance Project Plans* (EPA 1998) requires that all activities not governed by specific analytical procedures be completed under approved SOPs. If SOPs governing the inspection and maintenance of sampling equipment do not presently exist, they will be developed to ensure that sampling activities are conducted using equipment that is performing within manufacturer- or design-specifications.

Equipment used by INTEC ESH&Q oversight personnel will be evaluated, maintained, and operated within the manufacturers' specifications for each type of field or monitoring equipment.

9. DATA VALIDATION AND REPORTING

The collection of data in the field and by the laboratory is the first of several steps in evaluating conditions at a project site. After the data are collected, a series of evaluations and data reduction steps must be conducted to ensure that the data are acceptable and that the information is in a form that is usable by the end users.

9.1 Data Reduction

Data reduction is the process of converting raw data or instrument data into a usable form for evaluation by project personnel. Reduction of environmental data will take place at the laboratory. The data reduction activities performed at the laboratory convert the data into a form more usable for interpretive purposes for environmental risk assessment and verification of closure design.

Laboratory data reduction involves converting the outputs of the analytical instruments into sample and QC results. Laboratory reduction will be performed as defined in the analytical method. Laboratory deliverables include raw data and reduced data. This form of laboratory reporting will (1) ensure complete documentation of all aspects of laboratory analysis, (2) permit independent verification of reported results, (3) provide a form of data that is technically and legally defensible, and (4) ensure that end-data users can be completely confident in the results they deem usable.

Further data reduction may be necessary for use at the project level. When this is necessary, project management will determine the final data uses and parameter needs and will provide data sets in the form that project personnel require to complete their tasks. Examples of additional data reduction tasks include unit conversions and use of the data to perform sum-of-the-fractions calculations defined in 10 CFR 61.55(a)(7) (2001).

Scientists and regulators within the EPA, DOE Headquarters, DOE-ID, and Idaho DEQ may review the data to ensure compliance with HWMA/RCRA and DOE closure requirements. Individual regulators submit their requests to the PM for any data sets required to evaluate the post-decontamination characterization effort. Project management will provide requested information to regulators in the most usable form possible.

9.2 Data Validation

Analytical data validation is the comparison of analytical results versus the requirements established by the analytical method. Validation involves evaluation of all sample-specific information generated from sample collection to receipt of the final data package by the PM. Data validation is used to determine whether the analytical data are technically and legally defensible and reliable. The applicable analytical method QC guidelines will be used to validate the data with the exception of radioanalytical data, which will be validated exclusively using ER-TPR-80 (INEEL 1997). Data validation is one step of the DQA process that is used to determine whether or not the data meet the DQOs of the project. Additional steps of the DQA process are discussed in Section 9.3.

The final product of the validation process is the validation report. The validation report communicates the quality and usability of the data to the decision-makers. The validation report will contain an itemized discussion of the validation process and results. Copies of the data forms annotated for qualification as discussed in the validation report will be attached to the report.

9.3 Data Quality Assessment

The DQA process is used to determine whether or not the data meet the project DQOs. Additional steps of the DQA process involve data plotting, testing for outlying data points, and statistical hypothesis testing relative to the null and alternative hypotheses stated in the DQOs. The outcome of the DQA process is a statement that the statistical hypothesis testing suggests that the null hypothesis is accurate, that the null hypothesis has been rejected, or that not enough data exist to make a determinative conclusion based upon the hypothesis test used. In this latter case, either additional data must be collected to support the statistical hypothesis testing or the data user must make a decision with higher uncertainty than the levels expressed in the DQOs.

As stated in the discussion of completeness, data that are not necessarily invalid may be flagged during the data validation process. Flagged data are reviewed during the DQA process to determine whether the validation flags affect the intended use of the data. The determination of whether or not flagged data are used in statistical hypothesis testing is documented in the DQA report.

9.4 Data Use

Following data validation and DQA, the statistics generated during DQA will be used to make decisions relative to HWMA/RCRA clean closure and DOE Tier 1 closure. The data generated will be used to determine the concentration variance and sample mean (0) for each constituent of concern. For hazardous constituents, the data also will be used to calculate the 95% UCL of the sample mean and that value will be used as a conservative estimate of the population mean (F). The concentration corresponding to the 95% UCL will be compared to the action levels in the HWMA/RCRA Closure Plan to determine if the clean-closure performance standards have been met within the decision errors specified in the DQOs. For radionuclide analyses, the sample mean (0) as represented by the 95% UCL will be used to verify the PA.

9.5 Reporting

The laboratory may use its standard report forms when assembling the final Tier 1 data package documentation. However, each deliverable must conform to the criteria specified in the following references:

- Inorganic Data: Tier 1 deliverable as defined in ER-SOW-156 (INEL 1996)
- Organic Data: Tier 1 deliverable as defined in ER-SOW-169 (INEL 1995a)
- Radiological Data: Tier 1 deliverable as defined in ER-SOW-163 and addendum (INEL 1995b)

The Tier 1 data deliverables include all pertinent raw data, extraction notes, standard preparation, instrument printouts, and standard reference material certificates. The documents are used to establish technical and reporting standards only; their use does not imply the involvement of the Environmental Restoration Program in the TFF closure project. The ER SOWs that were prepared by the INEEL SMO have become the standard means by which analytical data deliverable requirements are defined by INEEL projects to both the INEEL laboratories and commercial laboratories used by the INEEL.

10. INTERNAL QUALITY CONTROL CHECKS AND FREQUENCY

To adequately assess the quality of sampling techniques, the cleanliness of sampling and shipping methods, and to help assess laboratory accuracy and precision, field QA/QC samples are submitted with natural samples at the time of custody transfer to the laboratory. Sampling conditions during the WM-182 and WM-183 post-decontamination tank heel characterization may be unconventional. If high radiation fields are encountered, field QC will be difficult to incorporate into the sampling process. However, depending on conditions, some field QC can be applied and will be collected. For this reason, it will be critical for laboratory QA/QC procedures and tolerances to be closely followed and met whenever possible. The following sections outline specific QC checks that will take place for this project.

10.1 Laboratory Quality Control

Laboratory QA/QC procedures and strict adherence to analytical method tolerances are critical to obtaining high-quality laboratory data. Each analysis conducted under the WM-182 and WM-183 post decontamination characterization will strictly adhere to all QA/QC procedures, QA/QC control limits, and method-specific corrective actions.

NOTE: Due to negative pressure in which samples are collected (the vacuum used for sample collection) and elevated temperatures in the tanks and (if samples must be separated into aliquots in the RAL) the hot cell, all VOA and SVOA results have the potential for low bias.

10.2 Field Quality Control

Field QC is usually accomplished by using approved sampling procedures and monitored by using trip and field blanks as described in Section 5.1.6, Sample Transport.

10.3 Inspection/Acceptance Requirements for Supplies and Consumables

Disposable sampling equipment will be checked before use to ensure it is made of material appropriate for the media being sampled. Sample containers will be obtained from vendors that certify the cleaning protocol used is appropriate for the analyses to be performed on the sample. Reagents used for sample preservation will be checked to ensure they are of the appropriate grade prior to use. Inspection and acceptance of these items will be documented in field logbooks or, when certifications are provided by the manufacturer, maintained in project files to ensure availability of these records.

11. SYSTEM AND PERFORMANCE ASSESSMENTS, FREQUENCY AND CORRECTIVE ACTIONS

It is not a requirement of this SAP that a formal audit of the analytical laboratory be performed before commencing with the WM-182 and WM-183 tank heels post-decontamination characterization. However, if deviations from the procedures outlined in this SAP are suspected during analysis, the PM and the PQAO should review the laboratory procedures that were used to obtain project data. In addition, an on-site meeting at the laboratory is encouraged to examine all procedures in action, to examine the facilities that will be used to complete data gathering activities, and discuss the technical project activities and intended data uses with laboratory personnel.

11.1 System and Performance Assessments

A system assessment is an evaluation of an entire system to ensure it will meet the requirements of the project. An example of a system assessment is an on-site laboratory audit that ensures the sample receiving, sample storage, sample analysis, data reduction, and documentation procedures used at the laboratory will meet the requirements of the project. A PA is the evaluation of the performance of one aspect of a system. An example of a PA is the insertion of performance evaluation samples to test the laboratory system. Performance evaluation samples are samples containing analytes of interest at known concentrations.

11.2 Corrective Action

Corrective action procedures are implemented whenever sampling, field monitoring, or laboratory analysis results do not meet the required QA/QC standards. The types of corrective action applicable to environmental analysis are field corrective action(s) and laboratory corrective action(s).

11.2.1 Laboratory Corrective Action

The laboratory manager, the laboratory QA officer, laboratory analysts, the PM, and the PQAO will be responsible for ensuring that all laboratory QA/QC procedures are followed. Situations requiring corrective action and the type of correction required will be as stated in the analytical method or the laboratory SOW. The laboratory will use internal QAPs and SOPs to complete all corrective actions identified both internally and externally. Completion of corrective actions will require notification to the PM or the PQAO of any laboratory situation that may affect the usability of the data. If notified of a laboratory non-conformance for which the laboratory seeks the project's required corrective action, the PQAO will:

- Notify the PM of the situation
- Devise a reasonable corrective action in conjunction with the laboratory staff and the PM
- Formally request the laboratory to implement the corrective action.

The PQAO and the laboratory QA officer will be responsible for monitoring the effectiveness of all corrective actions. The PQAO will report directly to the PM and INEEL management regarding problems or deviations observed, corrective actions proposed, and the effectiveness of ongoing corrective actions.

11.2.2 Field Corrective Action

The FTL and PM are responsible for ensuring all field procedures are followed completely and that field personnel are trained adequately. The FTL and the PM must document situations that may impair the usability of the samples and/or data in the field logbook. The FTL will note any deviations from the standard procedures for sample collection, COC, sample transport, or monitoring that occurs. The FTL will also be responsible for coordinating all activities relating to the use of field monitoring equipment, such as dosimeters and IH equipment. INTEC ESH&Q oversight personnel will provide any notations to the logbook to document non-compliant measurements taken during field sampling. Ultimately, the PM, or the FTL (at the discretion of the PM), will be responsible for communicating field corrective action procedures, for documenting all deviations from procedure, and for ensuring that immediate corrective actions are applied to field activities.

11.3 Reports to Management

The FTL and PM are responsible for ensuring all field procedures are completely followed and that field personnel are adequately trained. The FTL and the PM must document situations that may impair the usability of the samples and/or data in the field logbook. The FTL will note any deviations that occur from the standard procedures for sample collection, COC, sample transport, or monitoring. The FTL will communicate any deviations to the EA Closure PM, who will discuss these deviations with the independent PE to ensure any deviations are minor and do not affect implementation of the approved closure plan. The FTL will also be responsible for coordinating all activities relating to the use of field monitoring equipment (e.g., dosimeters and industrial hygiene equipment). The RCT and the IH will provide any notations to document out-of-compliance measurements taken during field sampling. Ultimately, the PM or the FTL (at the discretion of the PM) will be responsible for the effective communication of field corrective action procedures, for documenting all deviations from procedure, and for ensuring that immediate corrective actions are applied to field activities.

12. REFERENCES

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42 USC 6901 et seq., 1976, "Resource Conservation and Recovery Act of 1976."

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Appendix A

Cross-Reference between the Environmental Protection Agency QAPP and FSP Requirements and the SAP for Post-Decontamination Characterization of WM-182 and WM-183 Tank Residuals

Cross-Reference between the Environmental Protection Agency QAPP and FSP Requirements and the SAP for Post-Decontamination Characterization of WM-182 and WM-183 Tank Residuals

Table A-1 compares Quality Assurance Program Plan (QAPP) elements provided in the Environmental Protection Agency's (EPA's) *Requirements for Quality Assurance Project Plans EPA QA/R-5* (Interim Final)[f] (*EPA QA/R-5 Requirements*) and *Guidance for Quality Assurance Project Plans EPA QA/G-5* (*EPA QA/G-5 Guidance*)[g] to the 1989 EPA *Guidance for Conducting Remedial Investigations and Feasibility Studies under Comprehensive Environmental Response, Compensation, and Liability Act*[h] and to the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals*. Table A-2 compares the Field Sampling Plan elements in the 1989 EPA guidance document to the *EPA QA/R-5 Requirements* and *EPA QA/G-5 Guidance* QAPP elements to the elements in the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals*.

a. EPA, 2001, *EPA Requirements for Quality Assurance Project Plans EPA QA/R-5,* EPA/240/B-01/003, Office of Environmental Information, Washington, D.C March.

b. EPA, 1998, *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5*, EPA/600R-98/018, Office of Research and Development, Washington, D.C., February.

c. EPA, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, Interim Final, EPA/540/G 89/004, Office of Emergency and Remedial Response, Washington, D.C., July.

Table A-1. Comparison of QAPP elements in *EPA QA/R-5 Requirements* and *EPA QA/G-5 Guidance* documents to *Conducting Remedial Investigations and Feasibility Studies under CERCLA* and the elements in the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals*.

	EPA QA/R-5 Requirements/ *EPA QA/G-5 Guidance* QAPP Elements		*Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA/540/G-89/004) QAPP Elements		Applicable Sections in the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals*.
A.	Project Management				
A1.	Title and Approval Sheet		Title Page		Title and Approval Sheet
A2.	Table of Contents		Table of Contents		Table of Contents in INEEL Document Control Format
A3.	Distribution List		NA		NA
A4.	Project/Task Organization	2.	Project Organization and Responsibilities	2.	Project Organization and Responsibilities
A5.	Problem Definition/Background	1.	Project Description	1.	Project Description
				3.1.1.	Problem Statement
A6.	Project Task Description/Schedule	1.	Project Description	1.	Project Description
				3.1.1.	Problem Statement
				3.1.4.	Study Boundaries
A7.	Quality Objectives and Criteria	3.	QA Objectives for Measurement	3.	Quality Objectives and Criteria for Measurement Data
A8.	Special Training Requirements/Certification		NA		NA
A9.	Documentation and Records		NA	4.	Documentation and Data Management
B.	Measurement/Data Acquisition				
B1.	Sampling Process Designs (Experimental Designs)		NA	3.1.	Data Quality Objectives
				5.0	Sampling Process Design
B2.	Sampling Methods Requirements	4.	Sampling Procedures	6.	Sampling Procedures
B3.	Sample Handling and Custody Requirements	5.	Sample Custody	4.1.1.	Field Operations Records
				5.1.5	Sample Containers
				5.1.6	Sample Transport
B4.	Analytical Methods Requirements	7.	Analytical Procedures	7.	Analytical Methods
				8.1.	Laboratory Instrument Calibration
B5.	Quality Control Requirements	9.	Internal Quality Control	10.	Internal Quality Control Checks and Frequency

Table A-1. (continued).

EPA QA/R-5 Requirements/ *EPA QA/G-5 Guidance* QAPP Elements		*Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA/540/G-89/004) QAPP Elements		Applicable Sections in the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals*.	
B6.	Instrument/Equipment Testing, Inspection, and Maintenance Requirements	6.	Calibration Procedures	8.	Instrument Calibration Procedures
		11.	Preventive Maintenance	10.1.	Laboratory Quality Control
B7.	Instrument Calibration and Frequency	7.	Analytical Procedures	8.	Instrument Calibration Procedures
		9.	Internal Quality Control		
B8.	Inspection/Acceptance Requirements for Supplies and Consumables	9.	Internal Quality Control	10.3.	Inspection/Acceptance Requirements for Supplies and Consumables
B9.	Data Acquisition Requirements (Non-Direct Measurements)	12.	Data Assessment Procedures	3.1.3.	Decision Inputs
B10.	Data Management	8.	Data Reduction, Validation, and Reporting	4.	Documentation and Data Management
C.	Assessment/Oversight				
C1.	Assessments and Response Actions	10.	Performance and System Audits	11.	System and Performance Assessments, Frequency, and Corrective Actions
		13.	Corrective Actions		
C2.	Reports to Management	14.	Quality Assurance Reports	11.3.	Reports to Management
D.	Data Validation and Usability				
D1.	Data Review, Validation, and Verification, Requirements	8.	Data Reduction, Validation, and Reporting	9.	Data Validation and Reporting
		12.	Data Assessment Procedures		
D2.	Validation and Verification Methods	12.	Data Assessment Procedures	9.	Data Validation and Reporting
D3.	Reconciliation with Data Quality Objectives	12.	Data Assessment Procedures	9.3.	Data Quality Assessment

N/A = Not acceptable.

Table A-2. Comparison of FSP elements in *Conducting Remedial Investigations and Feasibility Studies under CERCLA* to the *EPA QA/R-5 Requirements* and *EPA QA/G-5 Guidance* QAPP elements and the elements contained in the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals*.

Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA/540/G-89/004) FSP Elements		*EPA QA/R-5 Requirements*/ *EPA QA/G-5 Guidance* QAPP Elements		Applicable Sections in the *Sampling and Analysis Plan for the Post-Decontamination Characterization of the WM-182 and WM-183 Tank Residuals*.	
1.	Site Background	A5.	Problem Definition/Background	1.	Project Description
		A6.	Project Task Description/Schedule	1.2.	Background
2.	Sampling Objectives	A5.	Problem Definition/Background	1.	Project Description
		A6.	Project Task Description/Schedule	3.1.1.	Problem Statement
				3.1.2.	Decision Statement
				3.1.3.	Decision Inputs
				3.1.4.	Study Boundaries
3.	Sample Location and Frequency	B1.	Sampling Process Designs (Experimental Designs)	3.1.7.	Design Optimization
				5.1.2.	Sample Location and Frequency
4.	Sample Designation	A9.	Documentation and Records	4.1.1.	Field Operations Records
		B3.	Sample Handling and Custody		
5.	Sampling Equipment and Procedures	B1.	Sampling Process Designs (Experimental Designs)	5.	Sampling Process Design
				6.	Sampling Procedures
		B2.	Sampling Methods Requirements		
		B6.	Instrument/Equipment Testing, Inspection, and Maintenance Requirements		
6.	Sample Handling and Analysis	B3.	Sample Handling and Custody Requirements	5.1.5	Sample Containers
				5.1.6	Sample Transport
		B4.	Analytical Methods Requirements	7.	Analytical Methods
				8.	Instrument Calibration Procedures